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MINE AND QUARRY

VOL. VIII, No. 1 JANUARY, 1914 WHOLE No. 27

A California Portland Cement Quarry

A MODERN COAL MINE

TREADWELL DIAMOND DRILLING

QUARRYING MARBLE AT PHENIX, MO.

PVBLISHED BY THE SVLLIVAN MACHINERY CO.

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MINE AND QUARRY

Vol. VIII, No. 1 JANUARY, 1914 Whole No. 27

A Quarterly Bulletin of News for Superintendents Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address.

The publication of inside facts is now required, at intervals, by the federal government, from newspapers and other periodicals. Mine and Quarry, being distributed without charge, although conducted "for profit," is not constrained to do this. The editors, however, have nothing to conceal from their readers, and are glad to report as follows: Mine and Quarry was started nearly eight years ago, and has been a healthy and robust publication ever since. Its aim is to tell why it is desirable, from the standpoint of its readers, to use "Sullivan" mining and quarrying and construction equipment; to describe new Sullivan machines and new uses for them. No advertising is accepted from outside firms. Its readers number engineers, owners, contractors, managers, superintendents, miners, master mechanics, professors and students in every state in the Union and nearly every country in the world. Mine and Quarry wishes its readers a Happy and a Prosperous New Year, and at the beginning of its eighth volume begs to express its hope that they will find its columns of some small interest or aid during 1914.

"*El Tigre* (Esqueda, Sonora, Mexico) —The diamond drill has struck a rich body of ore at a depth of 300 feet. The ore does not show on the surface, and except by drilling would not have been discovered. The drill was started July 1, and has been running steady ever since." —(E. & M. Jnl., Oct. 25, 1913.)

The diamond drill is not new, but its value as an ore-finder and as a means of exploration of known deposits is not appreciated or taken advantage of in many instances, in which it would unquestionably effect large savings of time, labor and money. The news note printed above tells of a result that is familiar to mining engineers the world over. The description of diamond drill work in Alaska, in this issue, illustrates a characteristic that puts the diamond drill in a class by itself among prospecting tools — the ability to bore holes and get cores at any angle of the 360. Think it over. Couldn't you employ a diamond core drill in some way in 1914 to get more definite information about your mine or mineral property?

The Sullivan Machinery Company is pleased to announce, through "Mine and Quarry," that Mr. John Oliphant, for many years president of the Harris Air Pump Company, of Indianapolis, has joined its engineering staff and will have charge of its Pneumatic Pumping Department.

Mr. Oliphant is one of the foremost of pneumatic pumping engineers. His extended experience and his thorough knowledge of and familiarity with problems of pneumatic pumping and transfer of liquids and other materials, covering a practice of twenty years in all parts of this country, supplemented by the engineering and manufacturing resources of this company, are assurances of the unusually high quality of the service which the Sullivan Machinery Company is prepared to provide in the field mentioned.

General view of Furnace Run Mine and Buildings, from the Allegheny River

A MODERN COAL MINE AND ITS EQUIPMENT

By George M. Crawford*

The Furnace Run mines, Nos. 1 and 2, of the Allegheny River Mining Company, are situated on the west bank of the Allegheny River, three miles north of Kittanning, Armstrong County, Pennsylvania. These mines are the most recent developments of the company, which owns approximately 35,000 acres, part extending along the Allegheny River for about twenty miles, in Armstrong county, and controlling an adjacent acreage of equal area; and about 7,000 acres in Jefferson county.

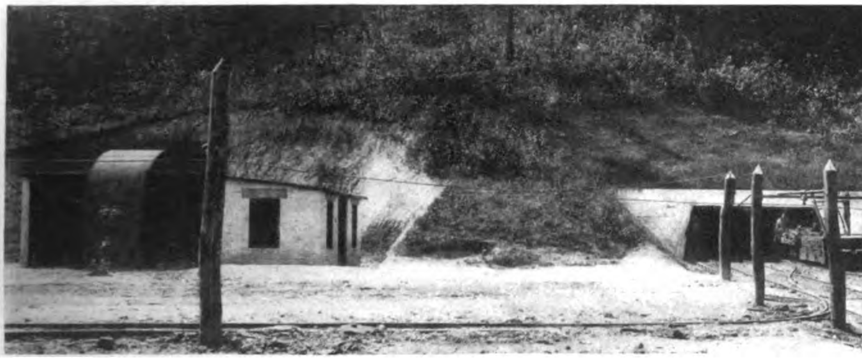
This company, whose headquarters are at Kittanning, is developing coal lands, which were opened up with the building of the Pittsburgh & Shawmut Railroad, through this section of Pennsylvania. This line, connecting with the Pittsburgh, Shawmut & Northern, at Brockwayville, Pa., provides an outlet to the Great Lakes, and through connection with other railroad systems, such as the D. L. & W., to eastern and western markets. While the southern terminus is now at Kittanning, extension to Freeport and connection there with the Pennsylvania lines are planned in the near future. An outlet to the south and west is provided by junction with the Buffalo, Rochester & Pittsburgh lines, four miles north of Kittanning.

The company's mines are in the Freeport, Kittanning and Brookville seams. The coal is sold to and marketed by the Shawmut Coal & Coke Company, of Buffalo, N. Y.

The Allegheny River Mining Company was incorporated in 1907, in Pennsylvania, with a capital stock of nearly three and one-quarter million dollars. Its bonded indebtedness is one and one-quarter millions, secured by some 23,000 acres of coal land, 500 railroad cars of the steel hopper bottom type, having a capacity of 100,000 pounds, six consolidation locomotives; and six cabooses. This equipment is leased to the P. & S. R. R., which pays the mining company interest on the investment and the cost of repairs.

Beside the Furnace Run mines, the company has the following operations: Hunts Run, near Brookville, Pa., a new mine with a daily capacity of 500 net tons, and an ultimate estimated production of 1,000 tons; Conifer, daily output 2,500 net tons; Seminole, daily output 2,500 tons; Chickasaw, a newer

* Farmers Bank Building, Pittsburgh.



Main Entry, Furnace Run No. 1 Mine; Fan at left

mine, daily production at present 1,500 tons—ultimate capacity 2,500 tons. The present output of the Furnace Run mines is 1,500 tons, which will later reach 3,000 tons, making an aggregate from all the operations of this company of 8,500 tons per day, which will reach 11,500 tons, when all are developed to capacity.

FURNACE RUN MINES

Work on the mines at Furnace Run was begun in July, 1912, and a detailed description of the methods and equipment employed will be of interest, because of the fact that the most up-to-date ideas and practice have been employed to make these mines as safe as possible, as well as economical and rapid producers. Both are drift mines, the No. 1 being developed with six drifts or entries on the Lower Kittanning, or "B" seam, while the No. 2 mine is opened with two drifts on the upper Freeport or "E" seam, which is about 180 feet above the Lower Kittanning. The average thickness of each of these seams is 42 inches, ranging from 36 to a maximum of 60 inches in some places. The coals in these seams are of excellent quality for domestic as well as steam purposes, being of a strong texture and of a blocky nature, thus permitting easy preparation for market and excellent condition.

METHOD OF OPERATION

The method of operation followed in both mines is essentially the same. The room-and-pillar system is used, the mine being divided into panels containing thirty rooms, as shown by the sketch of the No. 1 mine on page 772. The main entries are driven in parallel, four abreast, the two outside entries being used as air courses and the inside entries as haulage ways. The standard dimensions of all entries are 9 feet wide by 6 feet high, bottom being taken up or top removed, as necessary, to give proper height and grade. The grades range from one to three percent. The butt or panel entries are turned at right angles to the main entry, usually on the double-entry system, or on the single-entry system, when required by conditions. Rooms are turned from these butt entries on 50-foot centers, the standard dimensions giving a 25-foot room and a 25-foot pillar; although where top is good, the rooms are carried wider than this. They are driven to a depth of 300 feet.

The top encountered uniformly in both mines is a strong, black slate, and the bottom is of firm fire-clay. All of the coal at the Furnace Run mines is cut with machines. The entries, narrow places and rooms are driven by this means, and

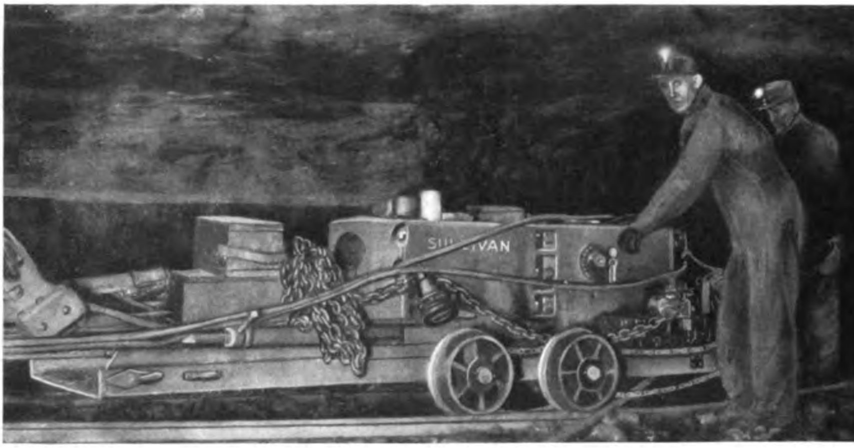


Fig. 1

Fig. 2

Fig. 3

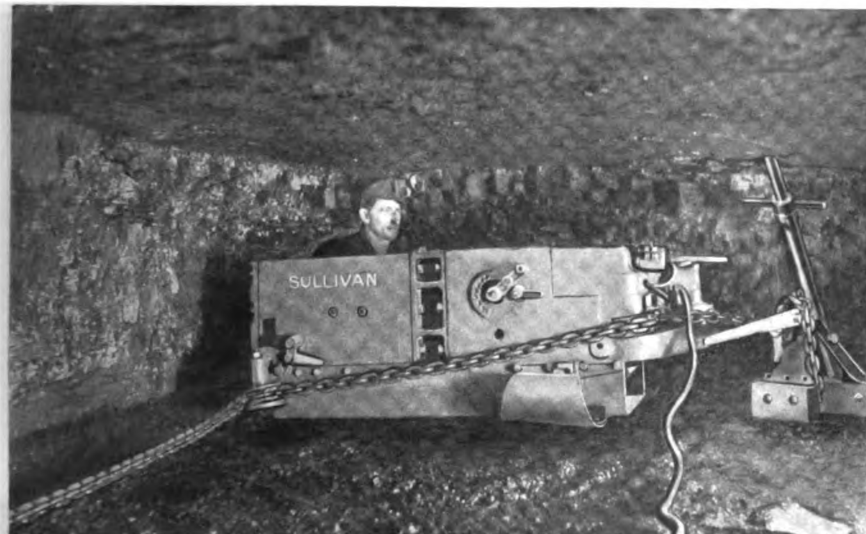


Fig. 4

Fig. 5

pillars will eventually be drawn by the same method.

A trial of various types of electric chain machines resulted in the adoption of Sullivan IRONCLAD continuous coal cutters, of the direct current pattern, cutting to a depth of 6½ feet under the coal, and giving a kerf or mining 5¾ inches in height. At the present time the company has seventeen of this pattern in service in its various mines. The high cutting capacity of the Sullivan IRONCLAD, and its strength and durability have provided satisfactory speed in production, as well as economy in repair costs.

The operation of the IRONCLAD machine

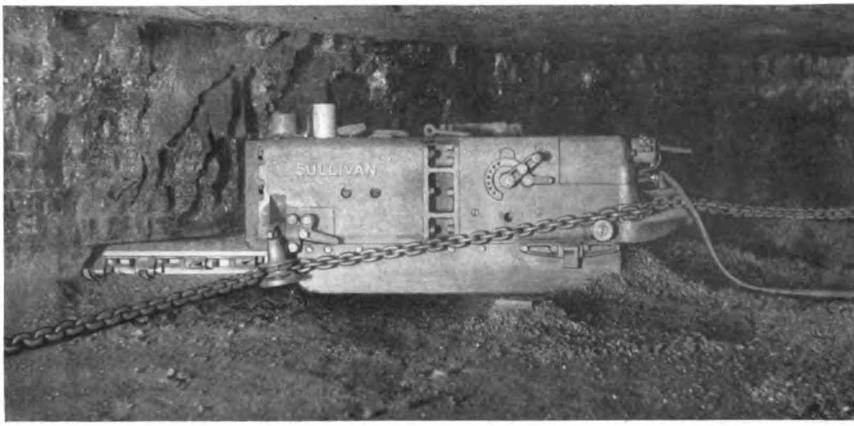


Fig. 6

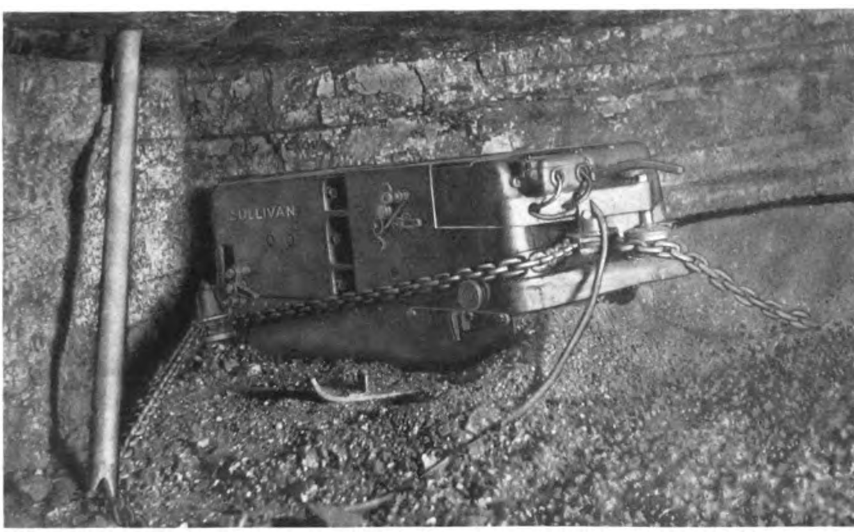


Fig. 7

is illustrated by the accompanying series of pictures, Nos. 1 to 9, taken especially for this purpose, in the Furnace Run mine. Figure 1 shows the machine on its self-propelling truck, moving from the heading into the room. This picture shows the customary method of transporting all equipment used with the machine on it when moving.

Figure 2. The truck wheels have been blocked, and the machine is unloading from its truck on to the floor of the room.

Figure 3. The machine has been squared with the right hand rib, and is ready to make the sumping or rib cut.

Figure 4. The sumping cut is completed, and the take-up rig and front jack are set in position, to permit the continuous

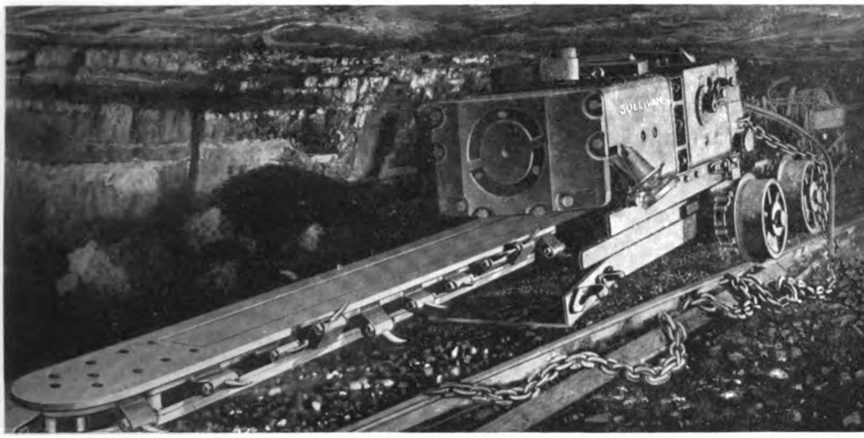


Fig. 8

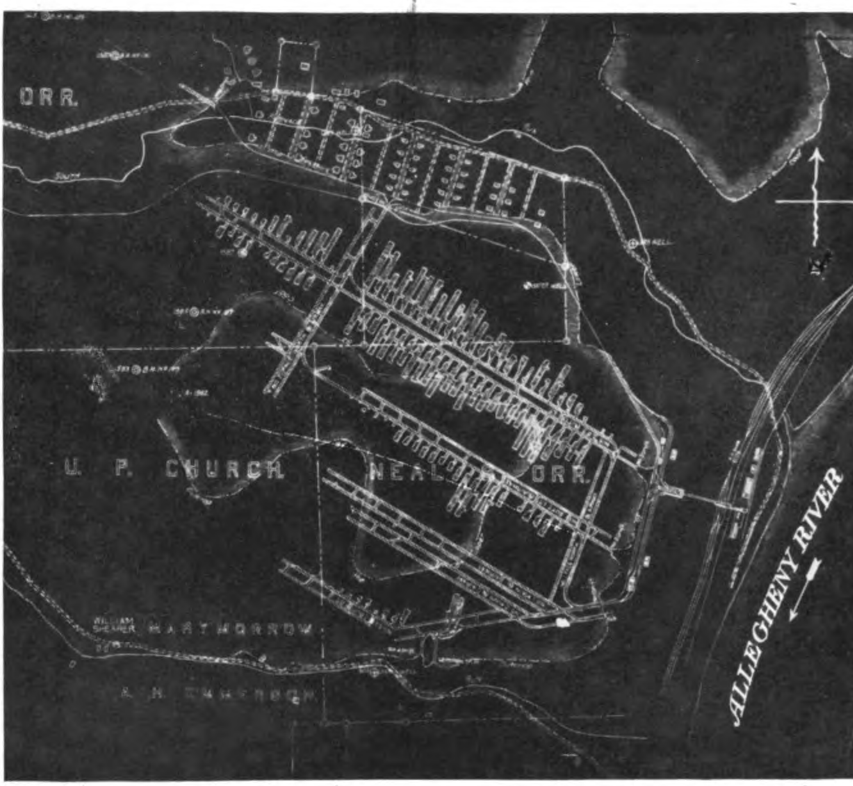
Fig. 9

undercut across the face. The machine has already started this cut.

Figure 5. This picture was taken to show how the IRONCLAD machine is handled, by manipulating the feed chain and the take-up rig, when an obstruction is encountered in the coal, such as a sulphur ball, spar or clay vein. The operator first throws the body of the machine forward, to cut in front of the obstruction.

Figure 6. The body of the machine is then drawn back, and the cutter bar permitted to cut ahead, so that the point of the bar cuts behind the obstruction. This nearly always dislodges the sulphur ball, or other impurity, from beneath the coal.

Figure 7. The machine has reached the left rib and is about to back out. The point of the cutter bar has been thrown to the left, and the jack set in proper position, so that the point of the cutter bar will follow the line of the feed chain on its way out and leave a perfectly straight rib.



A part of the mine workings of Furnace Run No. 1 Mine

Figure 8. The final operation of the machine consists in pulling itself back into position on the power truck, by means of its own power, for transportation to the next working place.

Figure 9. This shows the result of a break-down shot after mining with a Sullivan IRONCLAD coal cutter and indicates how well the coal shoots, after this machine. It also shows how blocky this coal is, and how readily it may be wedged out and loaded in large lumps, the most profitable condition for the market.

Figure 5 is also interesting, because it shows the coarseness of the cuttings made by the IRONCLAD machine. These are of a grade suitable for marketing as pea coal, or sometimes even as chestnut.

SHOOTING

When the undermining is completed, the loaders bore holes for blasting to the depth of the mining, namely, 6½ feet. Two shots are placed in the entries and three in the room. In the entries the shots are at each side, about a foot from the rib, while in the room a center break-down shot is fired first, followed by the rib shots, which are placed in the same manner as in the entries. The holes are bored straight in from the face. Black powder is used for shooting, the cartridges being 1¾ inches in diameter by 14 inches long for the side shots and 18 inches long by 1¼ inches in diameter for the center shots. In the cut, Fig. 9, the rib shots have not been fired.

HAULAGE

On main haulage entries 42-inch gauge track is employed, consisting of 40-pound steel rails. On butt entries 30-pound rails are used. Sixteen-pound rails are used in rooms, these being laid on steel mine ties to save vertical space. This affords a very permanent and substantial roadway for hauling the coal from the room faces clear to the tipple.

The mine cars, which are of 1½ tons capacity, after being loaded at the face, are pushed by the loaders to a room neck or parting, except when the rooms dip or rise on an unusual grade. In these cases the cars are pulled or delivered by a 3-ton gathering locomotive, having a reel of wire to permit its entering the room. These 3-ton locomotives make up trips from the separate panels, placing them on the butt entry, close to the main entry switch, where they are picked up by an 8-ton locomotive on the main entry, which takes them to the tipple. The smaller locomotive in the meantime crosses over through a "shoo-fly" to the parallel entry, distributes incoming empties to the parallel panel, and picks up loaded cars on that panel. This alternate process is repeated throughout the day.

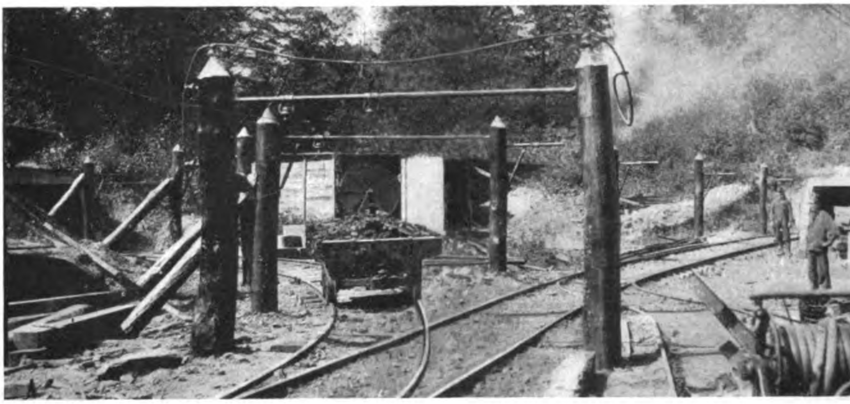
At the No. 2 mine, in the Freeport seam, the 8-ton locomotives deliver the coal to a side-track, outside the mine, where it is hauled over a tramway, by a 15-ton electric locomotive, a distance of about 7,000 feet, to the same tipple as that which serves mine No. 1.

TIPPLE AND CONVEYOR

Following out the progress of the coal from the mine, a modern and efficient plan of handling the coal on the tipple is giving excellent satisfaction. The coal comes to the tipple on two parallel tracks, as shown in the photograph on page 775. There are two car hauls, one for each track, of the knock-over dog type, driven by suitable clutch gears from an alternating current electric motor of 15 H. P. Only three men are required on the tipple floor — a top man, and a dump man for each of the automatic cross-over dumps. The car hauls or pullers are 28 feet long, and pull the cars from the entrance of the tipple to the crest or top, from which the cars are cut off singly by the top man, and run by gravity into automatic car stops or feeders of the Dempcy-Deggner pattern. These stops or feeders have a foot lever, by which the dump man can release one car at a time, at the same time stopping the next car automatically. The loaded cars bump into the empties, sending them across the dump to an incline, on which they return by gravity, to be picked up and hauled to the mine.

The coal falls from the dumps into a chute, thence into a clam-shell basket, suspended on scales, which weighs the coal and lowers it into a bin. The weigh baskets have an adjustable drop, by which the weighman can open them at any desired point, depending on the height of the coal in the bin.

From the bin a chute carries the coal to a reciprocating feeder, operated by a 10 H. P. AC motor, which is adjustable and feeds the coal into a retarding conveyor, believed to be the first installed in Pennsylvania. This is driven by a 75 H. P. AC motor, and consists of flights 48 inches wide by 16 inches high, attached to roller chains, and having a capacity of 500 tons per hour. It travels at a speed of 100 feet per minute. The coal slides in a steel-lined trough for a distance of about 300 feet, to the screen house, over the railroad tracks below. For a part of this distance it is straight, on a pitch of 27 degrees, then curves gradually to the level, and travels horizontally on to the end of the screen house floor. A trap door permits coal to be run on to a half-inch screen, from which the screenings supply boiler fuel for the plant. A simple but accurate system of screens and conveyors enables the balance of the coal to be properly sized for loading into cars, or for storage, so



Entrance to drifts at No. 2 mine; Fan in center

that any desired size, from run-of-mine to lump, may be handled to the proper destination. A 100-ton bin for coaling locomotives is among the storage places provided.

RAILROAD YARD

The yard, operated in connection with the screen house, shown in the picture on page 776, contains three loading or empty tracks and a passing track, with yard room on the tracks above the screen house for sixty railroad cars. A sixty-foot platform railroad scale, for weighing the cars, is placed below the screen house, and a yard for loaded cars, having a capacity of sixty cars, is below the scale again. This is parallel to the main line of the railroad, and easy to serve.

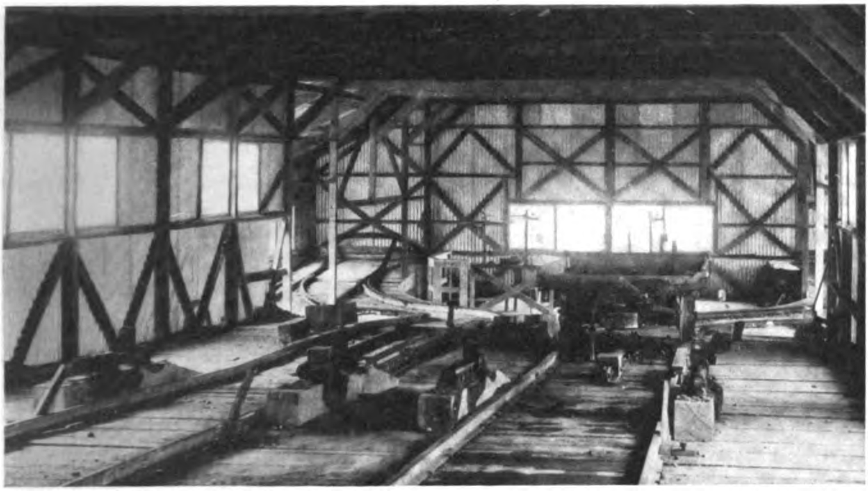
Cross-overs and three throw switches are arranged to permit handling the cars in the shortest possible space.

VENTILATION

The photograph on page 767 shows one of the drift openings in the No. 1, or Kittanning seam, mine; also at the left, a 10-foot diameter, double-inlet reversible steel fan, which provides fresh air for mine No. 1. This fan is driven by a 75-H. P. AC motor, and is at present running at half-speed. When the mine reaches its ultimate capacity, an additional motor will be installed at the other end of the fan shaft, to enable the fan to supply 200,000 cubic feet of air per minute, against a water gauge of five inches. The drive is by silent chain from the motor.

The air drift is 16 feet wide where it leaves the fan, and is gradually narrowed to the regular width of nine feet after passing the two main splits.

The Freeport, or No. 2, mine is ventilated by an eight-foot disc fan, driven by silent chain, from a 40-H. P. motor. The picture on this page shows the location of this fan at the intersection of two air drifts, which are at right angles to each other, owing to the contour of the ravine at that point. Wooden structures about 100 feet in length connect the fan with these drifts. The ultimate capacity of this fan is 95,000 feet against a water gauge of 1½ inches; mine telephones are placed along the tram road to the tipple, attached at intervals to the poles. These telephones are numbered, and their location noted on the mine map. They connect with the mine office and power house, so that in case of a break-down or accident along the road, the position of the trip can be reported immediately.



Interior of Tipple at Furnace Run

POWER PLANT AND BUILDINGS

The photographs on pages 766 and 776 show the power plant and surface buildings, which include a machine shop 36 x 100 feet, a foundry 20 x 24 feet, and wood working shop 18 x 60 feet. All these buildings are of steel frame and Hy-Rib construction, on concrete foundations. The power house contains two compartments, a boiler room 45 x 77 feet, and engine room 32 x 56 feet. Steam power is supplied by two batteries of two 150 H. P., return tubular boilers, or 600 H. P. altogether. There is room for an additional battery, to be installed when required.

Steam is generated at 125 pounds gauge pressure, the fuel being slack coal, delivered by the flight conveyor described above, in front of the boilers on the boiler room floor. Hand firing will be replaced later by under-feed stokers, and arrangements have been made for installing these when additional boilers are needed.

It is planned to install a scraper conveyor to remove the ashes from the ash-pit beneath the boilers. The pump room and condenser room are underneath the boiler and engine room floors, respectively, and contain, respectively, the feed pumps, water supply pumps for the railroad tanks and feed-water heaters, and a modern condensing outfit, including a new condenser, to care for an additional turbo-alternator.

Three-phase alternating current at 2,400 volts, 60 cycles, is furnished by a 500 K. W. turbo-alternator, and direct current for the mine locomotives is furnished by a 200 K. W. synchronous motor generator set. An additional 500 K. W. turbo-alternator is now being installed.

AIR COMPRESSOR

A Sullivan Class "WJ" 248-foot air compressor, size 12 x 7½ x 10 inches, is also being installed, to be driven by a belt from a 50 H. P. AC motor of 2,200 volts. This compressor will furnish air for the many purposes for which air is required in the engine room, machine shop, wood shop and foundry, and will also be piped up the hill to the tipple and motor barn, for use on air brakes on the weigh baskets, for cleaning motors, etc.

Screen House and Railroad Yards, Furnace Run, Pennsylvania

TRANSMISSION OF POWER

The alternating current is transmitted from the engine room to a point above the tipple in two separate circuits, one circuit connected to the fan motor, running at Mine No. 1 drift, and the other main circuit extending through to a substation at the No. 2 mine. This circuit furnishes current for the tipple motor at 220 volts AC; the fan at No. 2 mine, and a substation about 16 feet square, at No. 2 mine, containing a 200 K. W. generator set, the necessary switchboard, etc., for converting the current to D. C. at 275 volts, for use on the mining machines and locomotives. The transmission line is carried on poles 30 feet above the ground, the poles being of a very substantial character. A No. 6 copper static wire is carried on top of the poles and grounded at intervals to act as a lightning arrester, in addition to the regular arresters.

The motor generator set in the substation at No. 2 mine is connected in parallel with a set in the main power plant through the trolley wires. These two units furnish power for both mines, so that each helps the other to supply the varying demand for power in either mine or on the trolley line, as current is needed. Grooved wire is used for all entries and haulage ways, and the rails are bonded with 00 flexible compression bonds, and cross-bonded every 200 feet.

The machine shop, foundry and woodworking shop are very completely equipped for a plant of this character, and enable all ordinary and many unusual repairs, including the winding of armatures, to be done at the mine. Space will not permit a more extended description of this part of the equipment.

WATER SUPPLY

Water is pumped from the Allegheny River by condenser turbine pumps through the condensers, and is discharged into the hot well. From that point it is pumped by direct lift pumps to the railroad water tank, from which it runs by gravity to the feed water heaters and boiler feed pumps. These direct-lift pumps are equipped with special governors, which shut off the pumps automatically when the tank is full.

To secure this water supply, a cribbing was constructed of one-inch oak boards, 8 x 8 x 32 feet, sunk into the bottom of the river, with the top of the crib three feet below the river bed, and covered completely with clean stone and gravel, which act as a filter. A 14-inch cast-

iron pipe line, with six-inch auxiliary lines, is laid into this crib from the power house. The six-inch line is attached to a separate pump and acts as a reserve.

TOWNS

The company has built two settlements or mining towns to house its employes. That for No. 1 mine is about one-half mile from the tipple, and consists of about seventy houses. At No. 2 mine there are fifty houses. Each has its own water system, consisting of deep wells, with electrically-operated deep-well pumps, and a 20,000-gallon wood tank, with four-inch and three-inch cast-iron water main, fire plugs and hydrants, for distribution.

The photograph below shows the mine town at No. 2. It will be noted that there are several styles of houses, namely, seven-room single, five-room single, and ten-room double houses. All are wood, with asbestos roofs. They are painted different colors, as well as being of different patterns, so as to avoid monotony.

PLANS, OFFICERS AND ORGANIZATION

All plans for the various operations of the Allegheny River Mining Company were made by the company's engineers in their office at Kittanning and carried out by the various heads of departments, to each of which credit is due. The officers of the Allegheny River Mining Company are as follows:

Dwight C. Morgan, President, of Kittanning; H. S. Hastings, Treasurer, St. Mary's; Fred Norman, Chief Engineer, Kittanning. Directors, Dwight C. Morgan, Kittanning; Fred Norman, Kittanning; C. L. McIntyre, Kittanning; John S. Porter, Kittanning; H. S. Hastings, St. Marys, and Edwin E. Tate, Bradford, Pennsylvania.

The various departments and their forces for operation of the different mines are as follows:

Main Office: Kittanning, Pennsylvania. Dwight C. Morgan, President; F. A. Schmidt, Secretary; J. T. Armstrong, Purchasing Agent, and Charles Prior, Chief Clerk.

Engineering Department: Fred Norman, Chief Engineer; Charles P. Bailey, Assistant; John R. Herbert, Chief Draftsman; Frank King and William Atkins, Draftsmen. The Division Engineers are J. S. Emery, in charge of all mines east of the Allegheny River, J. I. Downs, having charge of all mines west of the Allegheny River. The Superintendent and Chief Clerks at mines are as follows:

Hunts Run and Conifer: Arnold Hirst, Superintendent, and B. L. Sterling, Chief Clerk; Mine Foreman, John Woodall, Hunts Run; and Samuel Woodall, at Conifer.

Seminole Mine: Arthur White, Superintendent; E. F. Oswald, Chief Clerk; Mine Foreman, R. C. Morris.

Chickasaw: Thomas Hall, Superintendent; C. R. Fair, Chief Clerk; David Jones, Mine Foreman.

Furnace Run: O. L. Mellinger, Superintendent; Chief Clerk, G. E. Doverspike; Mine Foremen, Daniel Hawkins at No. 1, and W. H. Shearer at No. 2 Mine.

David Whomond, Superintendent of Shops; Harry Molz, Chief Electrician. All of above mines are electrically equipped.

The Allegheny River Mining Company has additional developments in contemplation at Limestone, Nicholson Run, Glade Run, and Knapps Run, on the Allegheny River.

The writer is indebted to Mr. Fred Norman, Chief Engineer, for the information used in this article and to Mr. Herbert for the photographs, most of which he took especially for this article.

Where the headings met, after an advance of 1100 feet per month

MEETING OF THE MOUNT ROYAL TUNNEL HEADINGS

By D. J. O'Rourke*

The tunnel crews in the Mount Royal Tunnel of the Canadian Northern Railroad at Montreal shattered the last barrier between the two headings at seven o'clock on the morning of December 10th.

From the starting of the real tunnel excavation on September 6, 1912, to the time of holing through was fifteen months and four days, a splendid record of progress. The tunnel is 3¼ miles long, and the headings were driven 8 x 12 feet (No. 1 West) and 10 x 12 feet (No. 3 East) in size.

The average monthly progress per heading for the entire work was 420 feet, the total progress per month for all headings (four in the early stages) being 1,100 feet. The best progress for one heading in one month was made in May, 1913, when Heading No. 1 West, 8 x 12 feet in size, was advanced 810 feet in thirty-one consecutive working days. Sullivan rock drills have been used throughout the undertaking for all heading and "break-up" drilling. For the record above mentioned the drills were Liteweight, 2⅝-inch "FF-12" machines, with hollow steel and water attachment, by means of which compressed air and water combined were discharged at the drill bit. This combination was found effective in keeping the holes free of mud and in preventing the steel from sticking. The rock was hard limestone, interspersed with dykes of igneous rock. Four drills were mounted on arms, supported by a horizontal heading bar.

The best monthly footage in Heading No. 3 East (10 x 12 feet) was 510 feet,

*30 Church Street, New York City.

made in twenty-seven working days, also in May, with Sullivan 3⅝-inch "UH-2" water drills mounted on a combined drill carriage and muck conveyor. The rock in this heading was very hard, consisting of Essexite and Camptonite.

The tunnel methods and progress up to June 1, 1913, were described fully in MINE AND QUARRY for August, 1913.

PROGRESS SINCE JUNE 1

Since May 1st the monthly averages of heading advance have been 475 feet for No. 1 West and 485 feet for No. 3 East. So uniform has been the rate of progress that when the headings were still about 1,200 feet apart the time of holing through was fixed at 8:00 A. M. on December 10th. The chart on page 781 shows how the advance was plotted and how accurately the work followed the expectations of the engineers.

When the wide range in the character of the rock is considered, the engineering skill and resourcefulness and the thoroughness and efficiency of the working organization exhibited by this consistently uniform and rapid progress, are remarkable. Certain it is that a more varied assortment of hard rocks has seldom been encountered in any one instance in the history of American tunnel work. Trenton limestone, hard siliceous crystalline limestone, hard igneous intrusions or dykes of Bostonite, Camptonite, volcanic brecchia, Essexite and syenite were among the kinds of rock encountered, sometimes singly, sometimes in combination.

DRILL CARRIAGES

Heading No. 1 West ran into harder and harder rock after June 1st, and the 2⅝-inch drills were replaced, about three months later, with 3⅝-inch "UH-2" machines, for which a tunnel carriage with cross-bar was built, similar in principle to that previously designed for Heading No. 3 East, but modified in form and without the muck conveyor. The head end of this carriage is shown on page 780.

A large saving in time was gained by the use of these carriages, as compared with mounting these heavy drills on a bar or columns. This is indicated by the average monthly progress in No. 3 East heading, which rose from 350 feet, prior to the installation of the carriage, to 485 feet afterward.

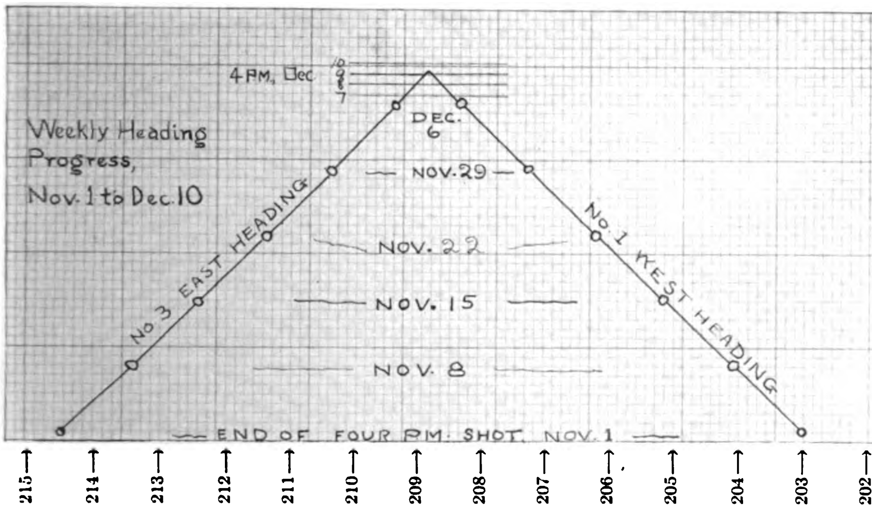
The carriage with the drills on it in No. 1 West heading (without conveyor) was run back to a siding after each round, to permit the passage of cars to the face. The girder or arm was there supported by a pipe hanger, carried by "A" frames at each rib.

Four "UH-2" 3⅝-inch drills were regularly mounted on the cross-bar of the carriage, and the whole round of 20 to 24 holes was drilled from a single setting of the carriage.

Owing to the great hardness of the rock, the holes were carried to as great a depth as the proper breakage of the ground would allow. Cut holes were drilled eight feet and rib holes 6½ feet deep. This gave an advance of 5½ to six feet per shift. After the round had been drilled, shot and muck cleared away, if the shift was not over, the crew, working on the bonus system, would run the carriage to the face again and start the new round before the next shift began. In this way a round was gained on an average every 48 hours, or seven

A Trip through the Heading

Sullivan "UH-2" $3\frac{5}{8}$-inch Rock Drills on the Mount Royal Tunnel Carriage, in Heading No. 1 West



Progress Chart for November and December (a rough copy of the original)

rounds were put in in six shifts, giving an average advance per working day of 19.2 feet of single heading.

The photograph on page 779 shows a trip of tunnel cars loaded with engineers, officials of Montreal, and prominent professional and business men preparing to ride through the tunnel, from end to end, at 3:00 p. m., December 10.

The engineers of the tunnel contractors, Mackenzie, Mann & Company, Ltd., estimate that the tunnel construction will be completed by the latter part of 1914. About 1½ miles of break-up excavation above heading grade are now done. The entire break-up will be finished by about May 1, 1914, after which the bench at each side of the heading will be removed, thus completing the section of the tunnel to its full area of 31½ x 21 feet.

The tunnel will probably not be lined throughout with concrete, but only in sections where the rock requires it. A large part of the tunnel length is driven through rock so hard and firm as to require no finish of this sort.

The Mount Royal tunnel is notable for the variety and hardness of the rock encountered; for the fact that it is the first of American tunnels to use a bottom pilot heading, with the break-up system of enlargement carried on jumbo timbers, thus permitting muck cars in the heading below to be loaded by gravity; for the first use of reciprocating type rock drills with hollow drill steel and water jet attachment; for the most rapid heading advance ever recorded for hard rock; for the first American use of a drill carriage and muck conveyor, and for the first American example of the practice of drilling shallow holes instead of deep ones, in a tunnel of so large heading area and over so long a period. It is also notable for the small loss of life attendant upon its construction thus far.

Government figures show that 4.7 men are killed per thousand engaged in tunnel work. In metal mining in the United States 4.3 per thousand lose their lives, and in coal mining 3.7. In building the St. Gothard Alpine tunnel 800 men were killed in eight years; at the Simplon, the latest of the great tunnels between Switzerland and Italy, 67 men out of 900 were killed in seven years' time.

The Mount Royal Tunnel; timbering for the heading and completed "break-up." Bench not removed

At Mount Royal about 1,000 men are employed. Thus far only a single man has been killed in the tunnel proper, during the fifteen months' work, and this man did not lose his life in the headings.

Sullivan Liteweight Water Drills on Heading Bar at Montreal

These accomplishments speak highly for the quality of engineering ability and of the organization and methods employed in prosecuting this interesting undertaking.

The writer is indebted to Mr. S. P. Brown, managing engineer for Mackenzie, Mann & Company, and to his assistants for the information and pictures used in this report.

NEW PUBLICATIONS

Air Compressors — Sullivan small, power driven Air Compressors. Capacities, 40 to 300 cubic feet per minute. Class "WG-3"; portable motor-driven air compressors, mounted on mine trucks, for underground use: class "WK-2." Bulletin 58 PM.

DIAMOND DRILLING AT TREADWELL, ALASKA

By A. Schoenberg *

The diamond core drill has, for many years, been of valuable assistance to mine owners and managers, not only in initial exploration, to find the location and thickness of veins of ore bodies, to determine whether or not the property should be developed, but also after the mine has been opened up and made a paying property, to prove up the direction and extent of the ore bodies, to determine whether they widen or diminish in size, and, by assaying the drill cores, to learn whether they are becoming richer or leaner in value as they are developed.

Service of this kind can be performed only by the diamond drill, of all prospecting machinery, since it alone is able to bore holes at any desired angle, from vertical to horizontal, whether on the surface of the ground, or in the depths of the mine; while, owing to the rapidity with which it works, and its accuracy, it is much more economical of time, labor and power than exploratory cross-cuts or winzes or drifts.

The cost of diamond drilling work naturally varies widely, not only with the district in which the drilling is done, but between different formations in the same district, and between different holes in the same formation. Skilful or careless operation of the machine; the use of diamonds of the first quality, or those of low grade, which wear rapidly, as well as the quality of the ground being drilled, are some of the factors which affect cost.

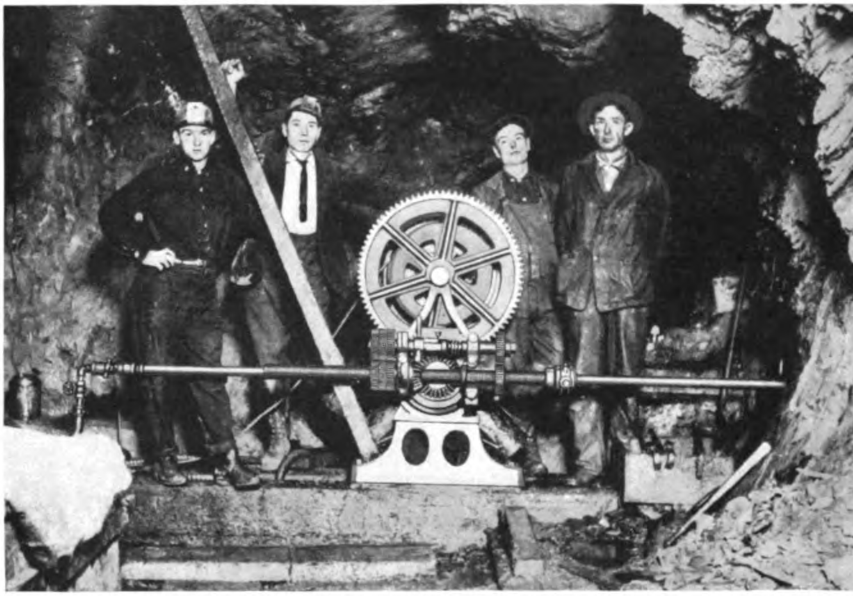
The following notes, however, are interesting not only as describing the use of a diamond drill for proving ore bodies in a developed mining property, but also because they give a fair idea of what progress and cost may reasonably be, with skilful handling, proper equipment and favorable operating conditions.

The Alaska Treadwell Gold Mining Co., at Treadwell, on Douglas Island, Alaska, has been using a Sullivan diamond drill the past year to prove up the deposits of gold ore on some of its properties. The drill employed is a Sullivan "Champion" screw-feed machine, with differential feed-gears, having a capacity of 1,500 feet in depth, and removing a core 1⅛ inch in diameter, employing standard "A" fittings; that is, hollow rods, core barrel, core shell, split spring ring lifter and bits.

Diamond drilling work began on April 6, 1913, at the "Mexican" mine, and continued until 4,318.5 feet of drilling had been completed. The illustration on page 784 shows the "Champion" diamond drill in operation. It will be noted that this machine is boring a horizontal hole. All drilling performed was cross cutting from the main drift of the mine. The space required for its operation was 6 x 6 x 15 feet, the rods and core barrel being 10 feet in length. The rock in which the drilling has been done is diorite, quartz, greenstone and slate. The diorite and quartz are very hard, and the greenstone has been ordinarily the best material for drilling. While not as hard as the diorite and quartz, it is still hard enough to provide very good cores. The slate encountered was very soft, but through it ran quartz seams, making very rough cutting, hard upon the machine and hard upon the diamonds. The diorite was so hard as to put a glass polish on a bit set with diamond chips, in from 4 to 6 feet of drilling. The diamond setter, Mr. J. M. Gibeau, got good results by setting some small diamond chips, which had been saved by the mine from work done about sixteen years ago; but although these were set up very sharp, the diorite rapidly polished them, so that progress in this material was very slow.

The following table shows the cost for five months, to August 31st, of operating the "Champion" machine on the 1400,

* Hutton Bldg., Spokane, Wash.



Sullivan "Champion" Diamond Core Drill, Alaska-Treadwell Mines, Douglas Island, Alaska

1300 and 1100-foot levels of the Alaska-Mexican mine, from the footwall and hanging wall of the famous Treadwell ore body. The distance drilled was 3,048.5 feet.

	Total Cost	Cost per ft.
Labor	$2434.36	$.798
Diamonds	1941.62	.637
Repairs	46.61	.012
Supplies	253.66	.083
Assaying	8.26	.002
Power (estimate) two machine drills at $65.00 each	655.00	.211
	$5339.51	$1.743

Number of karats used 21.57
Feet drilled per karat 141.3 ft.
Carbon Cost based on a value of $90.00 per karat.

No exact data are available on the cost of drilling for September, but the following is given as a close estimate:

	Drilling for the month, 584 ft.	Cost per foot
Carbon loss	$181.22	$.31
Labor	634.00	1.085
Power	131.00	.224
	$946.22	$1.619

During the month of August the total amount of drilling was 900.5 ft. The carbon loss for August was $.125 per foot drilled. The total cost for that month was less than $1.00 per foot.

The only alternative to proving up this ground with the diamond drill was to run tunnels or exploratory drifts. The cost of this is estimated at from $8.00 to $12.00 per foot, a very conservative figure. As 4,318.5 feet of drill holes were run, approximately $43,000.00 would have been expended for the same amount of prospecting by the tunnel or drift method. In other words, the company has saved approximately $35,000.00 on the amount of prospecting work which it has accomplished.

The information gained by the diamond drill was accurate, a high percentage of core being saved. The time taken to do the work in this manner was about one-quarter the time it would have taken if drifting or tunneling had been employed.

The deepest hole drilled by the "Champion" drill in the work described was a horizontal hole 1,006 feet long. From this over 900 feet of core were secured. This hole was bored through slate and quartz mixed.

In one of the holes put in with the diamond drill a flow of water was struck, which gave a pressure of about 300 pounds to the square inch. The stream delivered some 50 gallons per minute when the rods were removed. After finishing the hole, a pipe was swaged into it and a valve connected, thereby preventing the water from running into the mine. If a tunnel or drift had been the method of prospecting, the volume of water opened up would have been so large as to necessitate pumping it the 1100 feet to the surface.

The writer is indebted to Mr. R. A. Kinzie, Superintendent and Mr. J. M. Gibeau, diamond drill foreman, for the information given above.

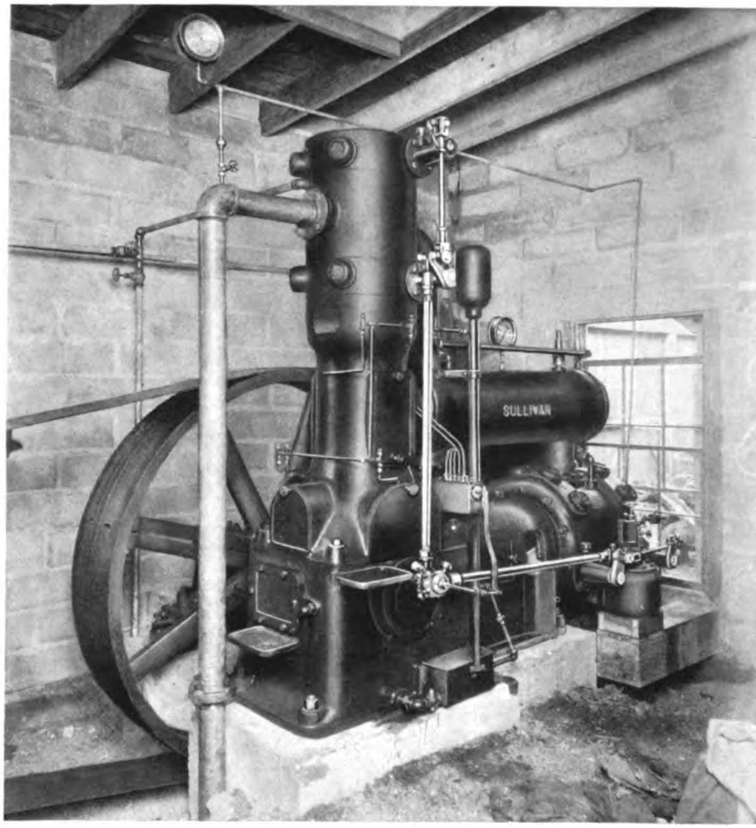
A POWER PLANT OF SMALL PROPORTIONS

Sullivan Angle-Compound Compressor an Aid Where Space was Limited

In the building and equipment of a power house under conditions which necessitated the close utilization of space, the engineers of the Reading-Bayonne Steel Casting Company have presented an excellent example of what can be accomplished in crowded quarters. In the portion of the company's grounds at Bayonne, N. J., where it was desired to locate the power plant, there were three restrictions in the way of building a structure of generous proportions. On one side was a public street, on another railroad tracks which run through the yard and into the plant, while another hindrance was an oil tank 60 feet in length imbedded in the earth at a place which the building logically might have covered.

It was therefore determined to erect on the ground available a concrete block structure 14 x 26 feet, one story in height and of the simplest construction. In this small building, which affords only about one-third the room previously used for power purposes in one of the main buildings, was placed a Sullivan 16 x 9¾ x 12-inch angle-compound air compressor with a displacement capacity of 628 cubic feet at 225 R. P. M., a 60-H. P. motor furnishing power for the compressor, a combined motor generator set consisting of a Crocker-Wheeler generator and a C. & C. generator, direct connected at opposite ends of a Crocker-Wheeler motor, and a switchboard. From the plant is obtained 70-volt direct current for welding; 230-volt direct current for crane service; compressed air, and through the switchboard passes alternating current of 230 volts for miscellaneous purposes, which is supplied by the Public Service Corporation of New Jersey. On the roof of the building is a set of transformers. Should it be required, there is still room for another air compressor of similar type to the one installed.

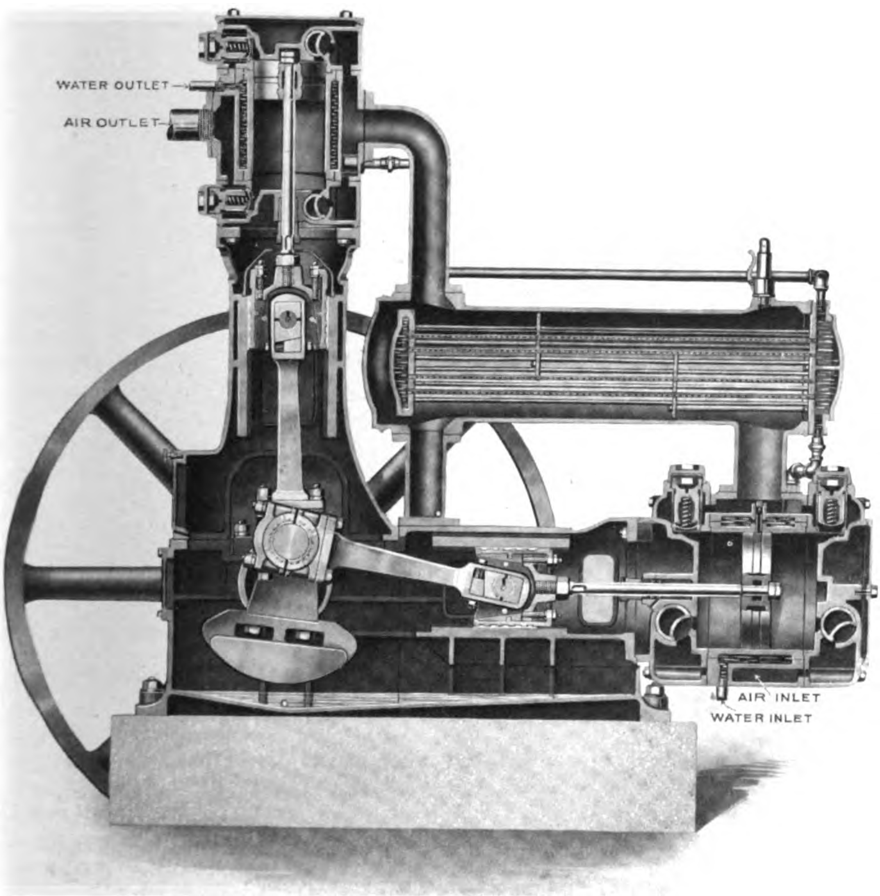
W. D. Sargent, chairman of the board of directors of the Reading-Bayonne Steel Casting Company, holds to the belief, as do many others, that foundry operators should get away from the problems of the power plant. In discussing the manner in which his own company had eliminated the question to a very great degree, he said that the need of enlarging the power plant as the foundry grows should be a minor question, and that it would be if more dependence was had on the public service corporations which invariably are willing to cooperate in solving the question of power. The increasing use of machinery in foundries, he pointed out, means increasing need of power, and this can be supplied with the greatest degree of flexibility by outside plants. This dependence also insures the benefits to be



How, with a Skylight Above and a Window at the End, an Angle-Compound Compressor was Acceptably Placed in a Corner of the Power Plant of the Reading-Bayonne Steel Casting Company

derived from the frequent improvements which are made in electrical machinery and methods. Obsolescence in the power plant should never confront the steel foundry, Mr. Sargent declared. His view, of course, cannot apply to isolated plants, which do not have access to a large public source of power.

The angle-compound compressor installed at the Bayonne plant is one recently brought out by the Sullivan Machinery Company, Chicago. Its economy of floor space made it of peculiar applicability, as may be observed from the accompanying half-tone. The compressor, driven by a 60-H. P. motor is giving the service previously rendered by two compressors, one of which was driven by a 60-H. P. motor and the other by a 50-H. P. motor. It is operated practically night and day. The illustration, which was taken before the floor was completed, shows how the machine was placed in a corner of the power house with only a narrow passageway around it, a setting which was made possible by placing a window in the side of the building much lower than it would be ordinarily and directly opposite the low pressure cylinder head and the intercooler, just above it.



Sectional Elevation, "WJ-3" Compressor

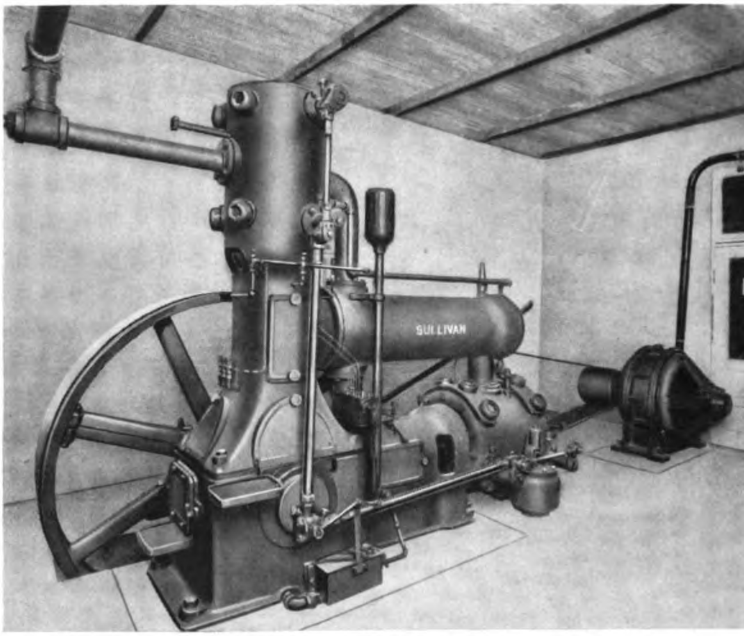
The removal of the head or access to the intercooler can thus be facilitated by the removal of the window. To facilitate the removal of the head of the high-pressure cylinder a skylight was placed directly over it. — *Iron Age.*

The Sullivan Angle-Compound Air Compressor, referred to in this article, is a new type, brought out during the past year. While the design is familiar in engine practice, it has not previously been embodied in power-driven air compressors of commercial sizes.

In addition to the economy in floor space secured by this compressor, as described above, the freedom from vibration, the simplicity and small number of working parts, flexibility of drive and high efficiency of this new machine render it attractive to all users of air power. The sectional view, on this page, shows the construction more fully.

The angle-compound design permits a very close balancing of the reciprocating masses.

In horizontal single or duplex compres-



Sullivan Angle-Compound Air Compressor in a Wisconsin Monument Plant; drive from rear

sors, good balancing is very difficult to accomplish, and the best that can be attained is a compromise, effected by attaching a centrifugal counterweight, of less weight than the reciprocating parts, which will partially absorb their horizontal disturbing effects without introducing vertical unbalanced forces of injurious magnitude, leaving the bearings, frames and foundations to absorb the remainder.

In the Angle-Compound compressor the disturbing influences of the horizontal and the vertical members tend to offset or neutralize each other, the maximum unbalanced effects of the vertical parts being produced when those of the horizontal parts are at minimum value, and vice versa.

The perfect balance thus gained in this compressor saves for useful work power otherwise wasted in friction and vibration. A coin will stand on edge on this machine when it is running at full load with the foundation bolt nuts removed.

The beneficial effects of such a marked reduction in forces tending to set up vibrations are manifold. One of the main obstacles to high rotative speed having been removed in this design, a smaller machine may be used for a given duty, provided it is designed with proper valves and valve areas for its rated speed, thereby involving savings in the original investment, space requirements and foundations.

The massive foundations necessary to absorb the unbalanced vibrations in other types are not required for the perfectly balanced Angle-Compound compressor, and it may be successfully operated in buildings where vibration is objectionable or on unstable or filled ground, where vibration would have a tendency to cause unequal settlement and throw the compressor out of alignment.

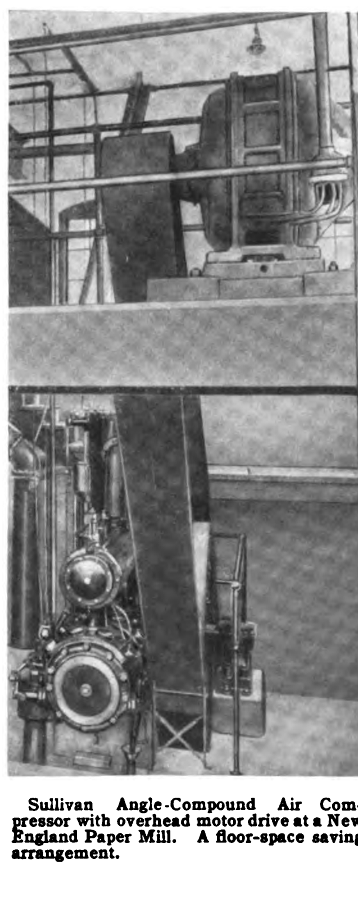
The heavy counterweight permitted by this design practically absorbs within the

shaft itself all of the heavy inertia loads which would otherwise have to be carried by the crank-shaft bearings, and leaves these important elements of the compressor free to perform their proper function of carrying the load due to the air pressure on the pistons and to support the weight of the moving parts, thereby greatly reducing power losses due to friction, trouble with heated bearings, et cetera. A further benefit is gained by a more uniform distribution of the working pressures around the circumference of the crank-shaft boxes. In the horizontal type of machine the wear due to the influence of piston load is all on the sides of the boxes, while with the ANGLE-COMPOUND type the piston load produces wear in both horizontal and vertical directions, with the result that the boxes require less adjustment, the wear is distributed over a greater surface, and both the shaft and boxes retain a more nearly cylindrical shape throughout their life, resulting in unusual freedom from pounding.

In the ordinary duplex design the stresses due to piston load are applied to the ends of a crank shaft supported in bearings several feet apart, and as the piston loads during certain parts of the revolution act in opposite directions, a twisting effect or couple is set up in a horizontal plane which must be resisted by the machine frame, the foundations, or both. Any lack of rigidity in these elements disturbs the alignment and produces a tendency toward heated bearings and increased friction. In foundations for duplex compressors, which are necessarily of large horizontal dimensions, if any settlement occurs, it is bound to be unequal; and the wide base or frame cannot be made stiff enough to resist the distorting forces of the settling foundation. The ANGLE-COMPOUND compressor foundation is short and narrow, and if settlement occurs, the foundation, in tilting from a level position, will move as a solid block or unit, and no distortion of the frame will result. Furthermore, this frame is of great depth in comparison to its width, giving it a rigidity far in excess of that found in the broad and more flexible base supporting the duplex compressor.

The unique arrangement of the cylinders in the ANGLE-COMPOUND compressor permits the location of both connecting rods side by side on the same crank pin. This feature reduces the distance between the center lines of the two cylinders from several feet, in the duplex, to the width of one connecting-rod box in the ANGLE-COMPOUND type, and practically eliminates the severe distorting forces previously referred to.

As already indicated, the compressor



Sullivan Angle-Compound Air Compressor with overhead motor drive at a New England Paper Mill. A floor-space saving arrangement.

is constructed with one high-pressure and one low-pressure cylinder, the latter located in a horizontal and the former in a vertical plane. The main or horizontal frame to which the low-pressure cylinder is directly attached is a massive casting supporting the entire machine. A heavy frame or pedestal supporting the high-pressure cylinder rests upon the main frame. A single crank pin drives both low and high pressure pistons. All moving parts except the valve gear are provided with positive automatic stream lubrication and are entirely enclosed within the frame. The main or low pressure frame is of the Tangye type, strongly ribbed, with bored guides for the low-pressure cross head and planed jaws for the reception of the crank-shaft boxes. It has oil-tight removable covers on either side over openings which are provided for access to the cross head; and a solid bottom designed to form a reservoir for oil. The pedestal supporting the high-pressure cylinder is similarly bored. It also has openings on either side to afford access to the cross head.

Both low and high pressure cylinders are made with separate liners forced into the main castings, the spaces between the liners and the cylinder castings forming the water jackets. The air passages in the cylinder castings cover the entire area outside of the jackets, the inlet and discharge sides being separated by longitudinal partitions on the sides of the cylinders. The surface on the outer side of the jacket walls provides considerable cooling area in addition to that of the intercooler.

The intercooling surface consists of a nest of aluminum tubes, through which the cooling water circulates, entering at one end, traversing one-half the tubes, and returning through the remainder. The ends of the tubes are expanded into two headers, the outer header being bolted against a packed joint on the outer end of the intercooler body, while the other header, inside the intercooler body, is left free to move with the expansion or contraction of the tubes.

When desired, the compressor may be driven by an electric motor mounted directly on the crank shaft. In this case the regular belt pulley is replaced by a heavy, square rimmed flywheel, securely keyed to the shaft, close to the compressor frame. A special crank shaft is supplied, of sufficient length to properly accommodate the electric motor, and is provided with a proper fit for securing the rotor or armature to it. A water wheel may be connected to the compressor in the same manner, if this form of drive is preferred.

A glance at the illustrations will show that a single crank pin takes the place of the two eccentrics customarily used for driving the valve motion in duplex machines. No supporting brackets or intermediate rocker arms are required.

A balanced disc on the end of the crank shaft carries a crank pin on which the connecting rods are hung for the inlet valve motion of both cylinders.

This consists of semi-rotary or Corliss valves, driven by adjustable motion rods, as employed in nearly all Sullivan Compressors.

The discharge valves are of the automatic poppet pattern, located in the cylinder leads, and acting in a direction radial to the axis of the cylinder.

The photographs on the accompanying pages show Angle-Compound air compressors that have been installed in various classes of service. In a later issue of Mine and Quarry will appear a description of an underground installation in a Western mine. [Editor.]

NEW PUBLICATIONS

Air Compressors — Sullivan Angle-Compound Air Compressors, for belt or direct-connected drive: a new type, "WJ-3," notable for high over-all efficiency, and great capacity per floor-space unit. Bulletin 58 SM.

"A" Quarry of Phenix (Mo.) Marble Company, showing extent of working faces, and Sullivan Channelers

QUARRYING MARBLE AT PHENIX, MISSOURI

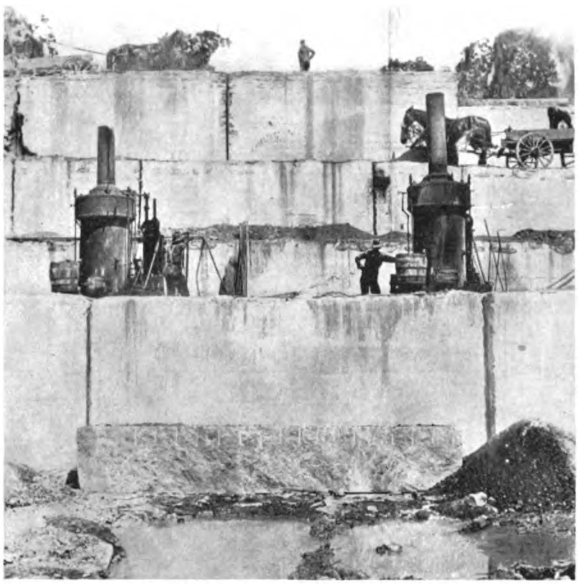
By B. B. Brewster*

[In Mine and Quarry for February, 1908, appeared a description of the deposits of white limestone, now frequently known as "Missouri Marble," at Carthage, in southwestern Missouri. At that time it stated that a subsequent article would describe quarrying methods at the neighboring center of Phenix, in Greene County, some forty-five miles to the northeast.

The following article is presented, with the apologies of the editor, for the long hiatus between the two, and with the hope that the material herewith presented is of sufficient interest to warrant consideration as an independent contribution. While the following description applies particularly to the quarries and methods of the Phenix Marble Company, the same conditions and methods apply to the other quarry operations in this district.—Editor]

The Phenix Marble Company operates quarries at Phenix, Missouri, mills at Phenix and Kansas City, and stone yards at Phenix, Kansas City and St. Louis. It was organized in about 1890, for the purpose of furnishing dimension stone and lime, and was originally known as the Phenix Stone and Lime Company. It owns approximately 270 acres of stone land at Phenix, from which it produces in the neighborhood of one-half million cubic feet of stone annually, thus constituting it one of the largest, if not the largest, of western producers of building stone. Its three principal grades are known in the trade as "Phenix Cut Stone," "Phenix White Lime" and "Napoleon Gray" marble, the latter frequently coming in competition with Tennessee gray marble, quarried at and in the vicinity of Knoxville, Tenn. The limestone at Phenix is white, with a slight grayish tint, more restful to the eye than the dead white. It is hard and highly crystalline, of a close, even texture, being what is geologically known as a Burlington limestone, belonging to the Burlington group of the

*705 Olive Street, St. Louis, Mo.



Sullivan "Y" Channelers on a 13-foot Cut in Phenix "A" Quarry

flint nodules occur occasionally in the formation, but do not occasion large waste, as the stone is usually quarried along them.

This penciling consists of tight veins not over an eighth of an inch thick. These occur more frequently in the lower ledges of stone, which are now developed to a depth of 70 to 80 feet. Fine effects in wainscot panels six to seven feet high are secured by sawing the stone across these veins.

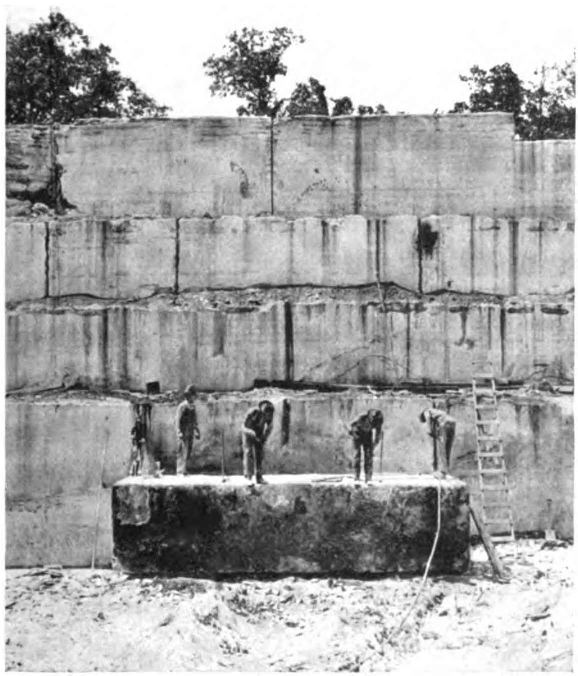
The only limit as to the size of mill blocks, of which large quantities are shipped, is the capacity of freight cars. Under the present system of quarry operation, the standard mill block is 10 feet long, 4 feet wide and 5 feet high, although practically any length and height on natural beds can be secured, if ordered in advance.

Mississippian carboniferous strata. It averages from 98 to 98½ per cent of calcium carbonate, with practically no iron or other impurities. It was originally composed of the remains of crinoids and other shell-fish of the Silurian and Carboniferous epochs, whose forms may be traced with more or less distinctness throughout the beds. When quarried and polished, these markings appear as a fine penciling, with just enough variation in color to provide both a fine texture and tone effect.

The ledges at Phenix are horizontal and from seven to thirteen feet thick, the thickness increasing with the depth of the deposit. The beds are interspersed by occasional mud seams, which in some instances have been washed out, leaving hollows and caves of great interest to the geologist. This feature is more marked at Carthage than at Phenix. Beds of

The company operates two quarries — "A" and "B" respectively — at Phenix. The "A" quarry has a working face 350 feet long, as shown in the illustrations on pages 791 and 793. The method of quarrying is that customary throughout this field, as well as in the Bloomington-Bedford Oölitic limestone district in Indiana; namely, the light overburden, consisting of a few feet of soil and rough cap rock or "cotton" rock, as it is called locally, is first stripped, exposing the regular beds of good stone below. Sullivan track channeling machines are then put to work to cut the floor into blocks. At the "A" quarry channels are cut lengthwise of the face at intervals of five feet, and to a depth varying with the thickness of the bed, frequently ranging from eight to 13 feet.

Every 23 feet headlines, or cross channels, are carried. As the channels usually run to a bed-plane or mud-seam, no drilling and wedging is required to free the blocks at the foot. They are turned over by driving wedges into the cut and by pulling the top of the block over with the quarry derrick and tackle.



A Block 23 x 13 x 5 feet cut by Sullivan Channelers in the "A" Quarry for Tulsa County Courthouse, Tulsa, Okla.

The illustration on this page shows one of these blocks turned over and ready for splitting. This gives a block 23 x 10 x 5 feet in size, and this quarry block is quartered to make four mill blocks, 10 x 5 x 5 feet, weighing approximately 25 tons each. Thus each square foot of channel gives 3.2 cubic feet of stone, and approximately 150,000 square feet of channel are cut in a year, with the four Sullivan "Y-7" track channelers, which this company owns. The quarries work practically the entire year, giving a channeling average per machine per day of about 85 feet, allowing for all delays and lost time. The Sullivan channelers are of the familiar single-gang, direct-acting, steam-driven pattern, which are used almost exclusively in the Missouri building stone districts, and which have practically replaced earlier types, used some eight or ten years ago. They carry vertical boilers and employ the regular five-piece gang or bit, the two outside and the center members of the gang being sharpened with an edge at right angles to the cut, and the other two, or inside members, being sharpened at an angle of 45 degrees with the cut. When flint is encountered, the three-piece "Z"-shaped bit is employed.

The channelers carry their own boilers, as indicated by the photograph, and burn about 1¼ tons each of Cherokee coal per day.

Tripod drills and hammer drills are employed for splitting up the blocks into mill sizes. The equipment includes two Sullivan tripod machines. The blocks are handled by two 50-ton derricks, with masts of Oregon fir, 24 inches square and 65 feet long, and having booms 20 inches in diameter by 55 feet in length. They have handled blocks weighing 75 tons and have been used to turn blocks weighing 100 tons each.

There are two mills at the Phenix Marble Company's quarry, known as "A" mill and "B" mill. The former is a wholesale plant, equipped with seven gang saws and a 30-ton electric traveling crane.

"A" Mill and Yard (wholesale), Phenix Marble Company

Power is supplied by two 100 H. P. boilers, which furnish steam for a 100 H. P. mill engine and a 40 H. P. high-speed engine, for driving a generator, which operates the hoist and derrick. The equipment of this mill includes a well 500 feet deep, driven in solid limestone, and producing 140 gallons per minute for water supply. At this mill there is also an air compressor.

At mill "B" there are three gang saws, an air compressor, two 125 H. P. boilers, mill engine of 125 H. P., a 78-inch blade diamond saw, as shown in the picture on page 795, and several planers.

The Phenix company is fortunate in having technically educated men in charge of its operation, as well as men of practical mechanical experience. Great stress is laid upon daily operation records. It has been found that these have a strong moral effect in producing good results, and are also of great value to the company in arriving at accurate figures as to cost and capacity. Several of the record and cost forms are reproduced on this and the following pages for the information of practical quarry men.

PHENIX
MARBLE CO
PHENIX, MO

CHANNELER NO. ____

DATE ____ 191__

QUARRY ____ LEDGE ____ LINE HEAD SIDE

LENGTH OF CUT ____ FT. ____ IN.

DEPTH AT START ____ FT. ____ IN.

DEPTH AT FINISH ____ FT. ____ IN.

SQ. FEET CUT TOTAL ____ PER H ____

LOADS OF COAL RECEIVED ____

BARRELS OF WATER USED ____

NUMBER DRILLS BROKEN ____

NUMBER GANGS USED ____

WIDTH OF SET OVER ____ FT. ____ IN.

HOURS RUNNING ____ HOURS ____ MIN.

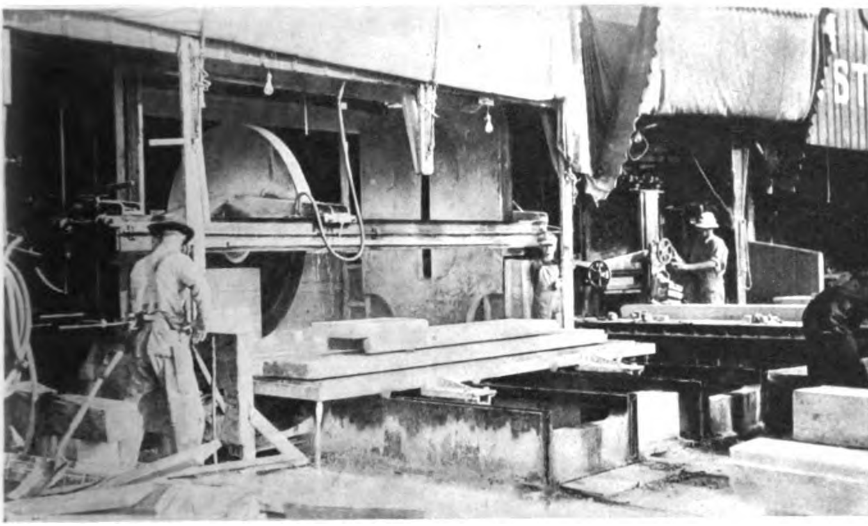
HOURS MOVING ____ HOURS ____ MIN.

	NAME	HOURS	RATE
CHANMAN			
SIDEMAN			
FIREMAN			

SIGNED ____ CHANMAN

NOTE REPAIRS AND DELAYS ON OTHER SIDE

Form P [illegible]



Stone Tools in the "B" Mill at Phenix

PHENIX MARBLE CO. PHENIX, MO

DAILY BLOCK RECORD

QUARRY ____________

DATE ____________ 191__

BLOCK		LENGTH		WIDTH		HEIGHT		CU FT	REMARKS
LEDGE	NUMBER	FT	IN.	FT.	IN.	FT.	IN		

	No. Men	Total Hours	Rate	Amount
Foreman				
Hoistman				
Quarryman				
"				
"				

Hours Pumping

Repairs (Time and Nature)

Remarks

Reverse of Block Record Card (Reduced)

STOCK SHEETS

Material ____________ Size ____________

Order No. ____________ RECEIVED Cost per Unit ____________

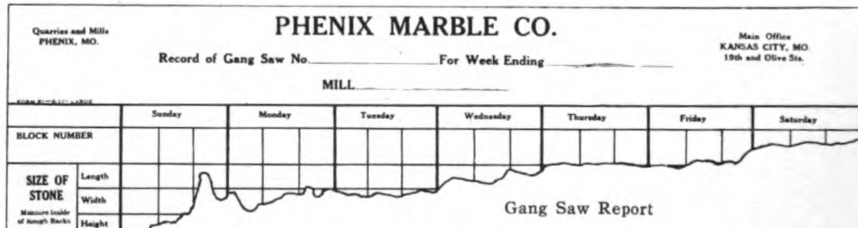
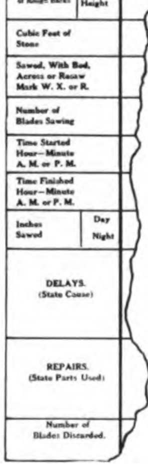
DATE		FROM WHOM PURCHASED	Quantity	Amount Invoice	Freight Cartage Etc.	GROSS COST
Received	Invoice					

Balance Dec. 31st ____ March 31st ____ June 30th ____ Sept. 30th ____

ISSUED

Month	Quantity	Rate	Amount	CLASSIFICATION		Folio Cr. Book
				Account	Auth.	

Store Room Stock Sheet for Receipts and Disbursements

Quarries and Mills PHENIX, MO.

PHENIX MARBLE CO.

Main Office KANSAS CITY, MO. 19th and Olive Sts.

Record of Gang Saw No. ______ For Week Ending ______

MILL ______

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
BLOCK NUMBER							
SIZE OF STONE (Measure inside of Rough Backs) — Length							
Width							
Height							
Cubic Feet of Stone							
Sawed, With Bed, Across or Resaw Mark W. X. or R.							
Number of Blades Sawing							
Time Started Hour—Minute A. M. or P. M.							
Time Finished Hour—Minute A. M. or P. M.							
Inches Sawed — Day							
Night							
DELAYS. (State Cause)							
REPAIRS. (State Parts Used)							
Number of Blades Discarded.							

Gang Saw Report

At Phenix the company maintains, in addition to its quarry equipment, a lime kiln, general merchandise store, hotel, boarding houses, cottages for employes, and a church.

At the general office of the company, at 19th & Olive streets, Kansas City, there is a modern cut-stone yard, with a two-gang mill, air compressor, planers, etc., and, as stated above, there is also a yard at St. Louis.

Phenix marble is supplied to a wide variety of trade for many classes of building construction. The company has regular customers in Boston, New York, Baltimore, Louisville, Philadelphia, Cincinnati, Milwaukee, Chicago, St. Louis and other western points, as well as in Canada.

Mr. Mastin Simpson is president of the Phenix Marble Company, with headquarters at Kansas City. Mr. Charles S. Cauble is manager of the quarries and mills, and Mr. David Miles commercial agent at Phenix; Mr. Howard Bryan, manager at St. Louis; and Messrs. J. A. Brown, manager of the cut stone department, and A. W. Burton, secretary, at Kansas City. MINE AND QUARRY is indebted to Mr. Simpson and Mr. Cauble in particular for their assistance in securing the above data, photographs and record forms.

BOOK REVIEWS

The publications of the Canada Department of Mines are always commendable for their completeness, and for the attractive form in which they are published. The report of the Mines Branch, for the year ending December 31, 1912, is an excellent example of this practice, being freely illustrated with half-tone cuts from photographs, sketches, and maps. It is accurately indexed for reference, and comprises 175 pages.

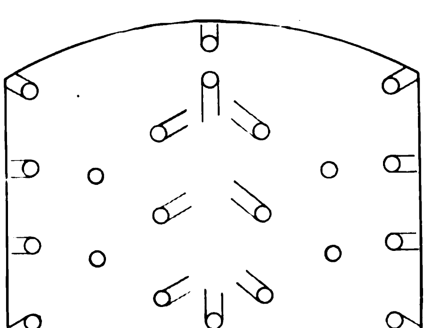


Fig. 1

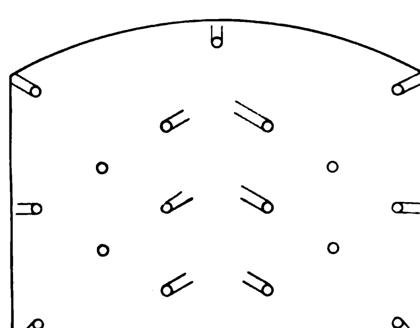


Fig. 2

THE ONEIDA NO. 2 ANTHRACITE DRAINAGE TUNNEL

By M. C. Reed*

The development of the anthracite mines in eastern Pennsylvania has been retarded, particularly during the last few years, by the presence of large quantities of water, which had to be removed at great cost, by elaborate systems of pumps. In order to reduce this cost, and to permit the opening up of lower levels of the mines, a number of drainage tunnels have been driven.

Among these may be mentioned the Lausanne or Mauch Chunk tunnel, near Mauch Chunk, Pennsylvania, which constitutes the outlet, to the Lehigh River, for what is known as the Buck Mountain gangway; a series of passages about thirteen miles in length, driven three or four years ago to drain fourteen different collieries in the Panther Creek basin, between Mauch Chunk and Tamaqua. This tunnel was 7,500 feet in length.

A second tunnel, driven about the same time, was the Oneida Tunnel, in Schuylkill County, which is 5,600 feet long, and drains the Coxe Brothers' mine, operated by the Lehigh Valley Coal Company. Water from this tunnel passes through the Tomhickon Valley, by way of the Catawissa and Susquehanna rivers, and replaced five large mine pumps which had previously been required.

Both of these tunnels were driven by the Portland Contracting Company, of Pottsville, Pennsylvania, Sullivan "UH" 3⅝-inch differential-valve drills being employed in both cases.

ONEIDA NO. 2 TUNNEL

In June, of last year, the same contractors completed a second tunnel at Oneida for the Lehigh Valley Coal Company, parallel to the first, and about one mile distant. While the first tunnel drains what is known as the No. 1 basin, the second, 7,030 feet long, drains the No. 3, No. 4, No. 5, and No. 6 basins, an area approximately four miles long by three-quarters of a mile wide. Comprised in this area are the Nos. 2, 4, 5, and 6 slope mines, and No. 3 shaft mine.

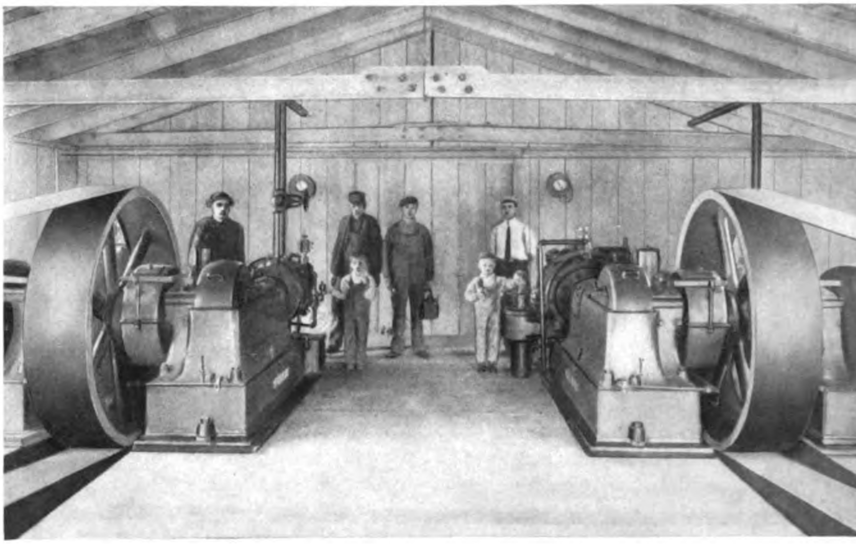
The tunnel pierces the mountain running between Oneida and Nuremberg, and discharges water from the mines into the Tomhickon Creek, doing away with the pumpage from twenty large mine pumps, the lowest of which has been obliged to lift water a distance of 500 feet; and permitting mine operation to the bottom of the basin.

This second tunnel is driven at a grade about 110 feet lower than the first. The tunnel slopes 23 feet in the entire length of 7,000, giving a good fall and rapid run-off for the water. The inside, or mine end, is at the foot of the No. 5 slope in the Buck Mountain vein; the outside, or surface end being in the Tomhickon Valley.

Work was begun on the inside end on

South Portal of Oneida No. 2 Tunnel, and Ventilating Set

* Scranton, Pennsylvania.



Sullivan "WJ" Belted Air Compressors at Oneida No. 2 Tunnel

the 16th of April, 1912, and on the surface end, near the little town of Nuremberg, on May 19th. The tunnel is 7 x 9 feet in cross section, and is driven its entire length through solid rock. This ranges from hard, close-grained, dark conglomerate, pitching at an angle of 45 degrees, at the inside end, successively to coarse-grained conglomerate, blue stone of a close grain, and finally red shale, at the surface end of the tunnel. The pitch of the rock flattens out, from the inside end, until it is practically horizontal when the surface is reached.

The coal company awarded the contract to the Portland Contracting Company, on the bonus-penalty basis, in order to secure as rapid progress as possible. A certain bonus was offered per day, for each day the tunnel was finished ahead of one year's time, and a like penalty per day was announced for each day over one year, required to complete the work.

EQUIPMENT AND ORGANIZATION

While the work on the approaches of the tunnel was proceeding, the contractors established a power house and compressor plant, near the top of the No. 5 slope, at Oneida, consisting of two Sullivan, class "WJ" cross-compound, belt-driven air compressors, with air cylinders 18 and 11 inches in diameter, by 14-inch stroke, with a rating of 680 cubic feet of free air per minute, at 165 R. P. M. These compressors were operated by belt from motors, taking current furnished by the Harwood Power Company.

The motors were of the 440-volt, alternating current type, of 150 H. P. each. The compressors are of the two-stage pattern, with intercoolers, of large cooling area, and having their main bearings, cranks, eccentrics, guides, and cross-heads enclosed in a dirt-proof casing, partially filled with oil, to provide automatic lubrication. On account of the hardness of the rock at the inside end, an air pressure of 120 pounds per square inch was maintained at the receiver, throughout the entire twenty-four hours, from the time the compressors were started until the work of tunnel driving was completed.

A 5-foot exhaust fan was installed at

each end of the tunnel, to provide the best possible ventilation. An 18-inch asphalted pressure ventilating pipe was carried as close as possible to the heading, so as to clear out the foul air resulting from the blasting as soon as possible.

A boarding house, providing good beds and good food, was established at each end of the tunnel.

The tunnel was driven three shifts per day, including Sundays and holidays. The labor force was made up as follows:—

1 Superintendent
2 Foreman
6 Chargemen
18 Drill Runners
18 Helpers
6 Muck Bosses
24 Muckers
4 Drivers
3 Dumpmen
1 Stableman
2 Compressor Runners
2 to 4 Blacksmiths
2 to 4 Blacksmith Helpers
1 Timekeeper
1 Clerk

TUNNELING METHODS

The bonus-penalty work was started with the actual driving of the tunnel, on July 7th, and included 6,800 feet. Work was carried on Sundays and holidays, as stated, and on the completion of the tunnel, on June 7, 1913, the contractor had finished 34½ days ahead of time. allowing for 454 hours of delay, for which the coal company was responsible, caused by high water. during January, March, and April.

At the outside end, Sullivan "FF-12" Liteweight 2⅝-inch differential-valve rock drills were employed, mounted on double-screw columns. These were replaced later, when the rock became harder, by Sullivan "UH-2" 3⅝-inch machines. Two drills were ordinarily used in each heading, but when unusually hard rock was encountered, three drills were regularly employed. When the third drill was required, this work was done by the "FF-12" machine, to drill what would ordinarily have been dry holes. Drills of another make (also 3⅝-inch) were used on the inside end.

The sketches on page 796 show the round which was employed.

Sketch No. 2, twenty-one holes, shows the hard rock round, and sketch No. 1., seventeen holes, shows the round in softer rock. The cut holes were drilled eight feet deep, and the relievers and side holes seven feet deep; a round thus ranging from 125 to about 160 feet of holes.

The drilling crew consisted of three drill runners, three helpers, a muck boss and four muckers, making eleven men, to which should be added one chargeman, one driver and one dump man. The holes were fired by an electric battery, the cut holes being fired first, then the relievers, and then the rib holes. One hundred pounds of 60-per cent dynamite were required to pull the round, giving an average advance per shift, for the entire work, of 3.4 feet per shift, or 10.3 feet per day of twenty-four hours, for each heading. This average includes all losses of time. The actual rock pulled ran to 5½ feet per working shift.

Slick sheets were placed in front of the face before each round was fired, to facilitate shoveling. The muck was removed by cars hauled by mules, each car being 8 feet in length by 4 feet wide and 4 feet high. Owing to the solidity of the rock, and the fact that it was to be used for drainage only, no timbering was required, and no lining was placed.

The best month's progress for a single heading was 387 feet, driven by Sullivan 3⅝-inch drills in the south end in bluestone, in May, 1913, and the best progress for both headings was also in May, amounting to 754 lineal feet of tunnel. The following table shows the progress by months, from April, 1912, to June, 1913, inclusive:—

	North End Feet	South End Feet	Total Feet
April, 1912.......	00	80	80
May, 1912.......	115	94	209
June, 1912.......	186	23	209
July, 1912........	228	000	228
August, 1912.....	219	186	405

September, 1912..	252	192	444
October, 1912.....	294	315	609
November, 1912 ..	321	372	693
December, 1912...	309	309	618
January, 1913....	327	342	669
February, 1913...	309	351	660
March, 1913......	351	300	651
April, 1913.......	327	240	567
May, 1913.......	367	387	754
June, 1913.......			234
			7,030

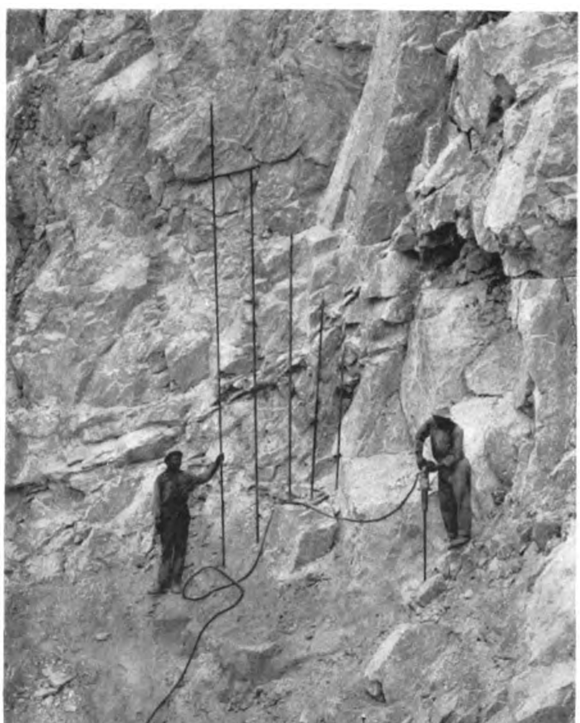
In addition to the contract price, the Portland Contracting Company received a bonus, for the 34½ days which they gained over the contract time, in completing the work.

The writer acknowledges with thanks the assistance of the various members of the Portland Contracting Company in the preparation of this article.

A CALIFORNIA CEMENT QUARRY

By W. J. McRae*

The Pacific Portland Cement Company's quarry is located in El Dorado County, five miles east of Auburn, Placer County, California. Transportation to the kilns at Cement, California, is furnished by the main line of the Southern Pacific, from Cement to Auburn and by their own private road from Auburn to the quarry. The construction of this latter road was notable because it was necessary to build one of the largest re-enforced concrete bridges in the United States, in order to cross the American River. A view of the quarry site is shown on the front cover of this issue.



Sullivan "DB-19" Air-Jet Sinker and a set of steel to 20 feet. Pacific Portland Cement Co.

The lime rock is of a very high grade and is found in a ledge which may easily be traced by outcroppings whose general direction is from north to south.

The deposits now being worked were first prospected in 1910 with a Sullivan Diamond Core Drill. The accompanying photograph, showing four consecutive "pulls" of core, averaging nine feet, four inches long, indicates the quality of the stone and its extent.

Active quarrying operations were begun in March, 1912 by the "glory hole" method. The rock is hauled by cable in six-ton cars from the bottom of the glory

* Sheldon Bldg., San Francisco.

hole to the crusher, where it passes through a No. 9 crusher into a 60-inch x 10-foot screen; thence into bins, and from there it is drawn through two No. 6 crushers, distributed into the conveyor belts and carried a distance of 425 feet to the bunkers. The product is then ready to be loaded on cars for transportation to the kilns at Cement, California. The capacity of the crusher plant is 1,500 tons per ten-hour day.

POWER PLANT

A 100 H. P. induction motor is used to drive a Sullivan "WJ" Compressor, which is of the cross-compound self-oiling belt-driven type. The low pressure cylinder is 16 inches in diameter; high pressure cylinder 10 inches, and stroke 14 inches. This gives the machine a displacement capacity of 537 cubic feet at 165 R. P. M. The inlet valves are of the standard Sullivan semi-rotary type, with a clearance cut in the rear, filled by a film of air, which forces the valve constantly toward its seat. The discharge valves are of the direct acting type, arranged radially in the cylinder heads, in order to give low clearance. They seat in brass cages, which in turn are set in pockets in the heads, making them easily accessible. This arrangement permits the ready removal of the valves and their seats for regrinding, thus insuring tightness, one of the most vital factors in the economical operation of a compressor.

The air pressure carried is 100 pounds per square inch at the receiver. A 1,000-foot pipe line, 5 inches in diameter, distributes the air to glory holes No. 1 and No. 2, also to the open face quarry, No. 3.

From the standpoint of the quarry operator, one of the most interesting features of this plant is the successful application of small hammer drills. All blast holes, even as deep as twenty feet, are drilled with machines of this type, thus, on account of their low air consumption, making possible a large output of rock with a much smaller air plant than would otherwise be required. Eighteen "DB-19," 41-pound, and seven "DB-15," 25-pound, Sullivan air-jet hammer drills are operated from the one hundred horse power compressor previously mentioned.

The average time for drilling a 20-foot hole with a "DB-19" drill is one hour and fifteen minutes. The average drilling per tool in a 10-hour day is 100 feet when the holes are from 10 to 20 feet in depth. Considerable difficulty was encountered in getting 20-foot hollow steel. It finally became necessary to weld two pieces at the quarry. The change in gauge is made with changes in length of 3½ feet.

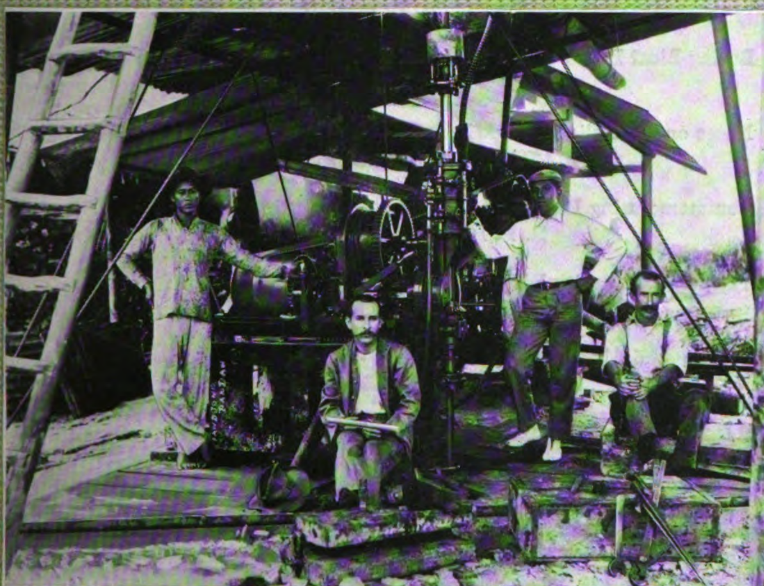
The "DB-15" tools are used principally for putting pop holes into the chunks and boulders that are too large to be handled without being broken up further.

The writer is indebted to Mr. Harold M. Powers, superintendent, for much of the information obtained.

Diamond Drill Cores from Pacific Portland Cement Company's Property

MINE AND QVARRY

VOL. VIII, No. 2 APRIL, 1914 WHOLE No. 28



A Sullivan Diamond Drill, Prospecting for Tin in the Dutch East Indies

A PACIFIC COAST DRILL BOAT

THE PERRY MEMORIAL

AUSTRALIAN COAL NOTES

PVBLISHED BY THE SVLLIVAN MACHINERY CO. 122 S. MICHIGAN AVE., CHICAGO.

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MINE AND QUARRY

Vol. VIII, No. 2 APRIL, 1914 Whole No. 28

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address.

Our front cover illustration shows one of two belt-driven diamond drills, prospecting for tin on Billiton Island. The man seated at the right is the drilling superintendent, sent from the United States. His crew are natives. Billiton is a small island between Sumatra and Borneo. The tin deposits are rich and extensive. They are being exploited by a Dutch firm, the Billiton Tin Company.

"Do not send any more of this junk here," is the comment with which a copy of MINE AND QUARRY was recently returned to the publisher. The information is welcome and no more "junk" will be sent to that particular address. The publisher will refund postage to any recipient of MINE AND QUARRY, who will take the trouble to return the magazine or to advise them that MINE AND QUARRY is of no interest and is "junk" so far as he is concerned.

MINE AND QUARRY'S mailing list is a large one, and while it is anxious that all those interested in the subjects discussed should continue to receive copies, it is equally desirous that the waste distribution be as small as possible. On the other hand, you can't hurt the editors' feelings by returning the enclosed card, whether you ask for information, have suggestions to make, or merely say, "Keep on sending MINE AND QUARRY."

NEW CATALOGUES

Core Drilling by Contract. A booklet describing Sullivan Diamond Drills and the facilities and experience of the Sullivan Machinery Company in performing mineral prospecting and engineers' test borings by contract. Booklet No. 113, 32 pp., 5½x3¼ in., liberally illustrated.

Sullivan Rock Drills. Describes rock drill mountings and accessories, such as tripods, columns, quarry bars, gadders, wagon mounts, autotraction rigs, steel, hose, tools, drill sharpeners, et cetera. Bulletin No. 66-B, second edition, 36 pp., 6x9 in.

PERSONAL

The Sullivan Machinery Company announces that at its recent annual election Mr. Charles K. Blackwood, of Chicago, was elected vice-president of the company, succeeding Mr. William H. Elliot, of Keene, N. H., resigned. Mr. Blackwood was also re-elected assistant treasurer of the company, an office that he has held for the past twelve years.

Mr. G. W. Bateman has been recently appointed general purchasing agent of the company, with headquarters at Claremont, N. H.

Mr. M. G. Doll, for several years district manager for this company at Salt Lake City, has been appointed its representative on the west coast of South America.

Messrs. Pay and Brinck, Todbodgade No. 4, Christiania, have been appointed agents in Norway for the Sullivan Machinery Company.

A new local office of the Sullivan Machinery Company will be established next month at Melbourne, Victoria, in charge of Mr. Raymond B. Hosken, hitherto associated with the general office at Chicago. The Australasian headquarters of the company are at Sydney, N. S. W.

Drill Boat "Burrard" before mounting the drills

Detail of Drill Towers and Hoisting Engines, Drill Boat "Burrard"

A PACIFIC COAST DRILL BOAT

By W. R. Austin *

The submarine drill boat described below is of interest, first, because of its great capacity; second, because it represents what is considered the most advanced practice in design and equipment, and, third, because it is the first vessel of this kind that has been put in commission on the Pacific Coast.

Several months ago Messrs. Henry, McFee, and McDonald, of Vancouver, were awarded a contract to excavate 150,000 cubic yards of rock to a maximum depth of 51 feet below high-water line, in Burrard Inlet, Vancouver Harbor, British Columbia. This is in connection with a pier which the Canadian Government is building. The depth of water at the pier site ranges from 10 or 15 feet at the shore to nearly 50 feet at the outer end of the dock at high tide. The rise and fall of the tide here is about 15 feet.

In order to secure the specified depth of water in the dock, it will be necessary to drill and shoot to a depth of 52 or 53 feet, so that the actual depth of rock bottom to be lifted ranges from two or three feet in deep water to 40 or 42 feet near the shore.

DRILL BOAT "BURRARD"

The contractors have recently built and placed in commission, to perform the necessary rock drilling, the submarine drill boat "Burrard," which, so far as the writer has been able to learn, is the first drill boat on the Pacific Coast. The work outlined above calls for a vessel of liberal dimensions and drilling capacity, comparing favorably in these respects with any similar boats on the Atlantic or Great Lakes.

The "Burrard" is 118 feet long over all, 30 feet 4 inches wide, and 8½ feet deep. The hull is built of Oregon pine planks, the bottom being five inches, sides six inches, and deck planks four inches thick. The hull is divided fore and aft by four bulkheads of 12x6 inch timbers.

The boilers, pumps, etc., are protected by an ample deck house, as shown by the photograph on page 804.

Steam for the pumps, drills, and engines is furnished by two 60-inch x 14-foot "Eclipse" boilers, built by Leonard & Sons, of Welland, Ontario. Each boiler is mounted in a steel casing, and is lined for burning fuel oil. The oil-burning equipment is known as the Dahl system, and is well adapted for the heavy California crude oil. Oil storage is provided by a tank, holding 7,500 gallons, located beneath the boilers in the central fore and aft compartment of the hull. This compartment also contains a 5,000-gallon tank for feed water (fresh). The pumping equipment comprises two pressure pumps for feeding fuel oil to the furnaces, two boiler feed water pumps, and two pressure pumps, size 10½x6x10 inches. One of these last supplies water to the drill jets; the second is connected as a supplement to the drill jet supply, but is used ordinarily for transferring oil to the storage tank from an oil scow. It is also connected direct to the fire hose lines.

A small dynamo and engine, run from the boilers, furnish electric light.

STEADY SPUDS

At each corner of the hull is placed a spud 72 feet in length by 30 inches square, of timber, shod with cast-iron shoes, mounted in heavy timber spud boxes, and rigidly braced by steel trusses. These spuds are for the purpose of supporting the hull while drilling is going on, thus forming a rigid platform for the drills. At the top of each spud is mounted a 30-inch cast-steel sheave with structural steel frame, and on the front or outside of the spud, about 15 feet above the deck, is a steel holder or grip into which the ends

* Hutton Bldg., Spokane, Wash.

Boilers and piping of the "Burrard"

of the steel cables are secured. Back of each spud on the deck is set a pair of double-cylinder, double-drum spud engines, the cylinders being 7½x8½ inches, and the drums being grooved for 1⅜-inch steel cables. These drums will handle a cable long enough to force the spuds into water 52 feet deep.

The operation of the spuds is the same as the usual method on modern dipper dredges, viz: One cable runs from the holder on the front of the spud, up to the sheave at the top and down the back side of the timber, to a sheave on the deck. When this cable is wound up on the drum, the spud is forced down into the bottom. To lift the spud and free the boat, a second cable is provided, which runs from the holder on the front of the spud timber down to a sheave set on one side of the spud; then up over a second sheave placed on the deck, and to the other end of the hoisting drum. Both cables are on the same drum, at opposite ends, and as one cable is hauled in the other is paid out.

ANCHORS AND CABLES

For pulling the boat off and on the range and for getting it accurately into position, four anchors are provided, with a cable from each, running to a different corner of the deck. These cables can be pulled in or slacked off by means of a pair of 6½ x 8½ inch double-cylinder four-drum reversible hauling engines, located inside the deck house. Each drum is provided with a brake band, and all four cables, or any one, may be handled at once.

DRILL TOWERS

On one side of the boat, as shown in the photograph on page 802, are mounted five structural steel drill carriages or towers, 47 feet high above the deck and having a base of 13 feet athwart the ship. The length of the base fore and aft is 10 feet. The drill towers are mounted directly on inverted sections of 80-pound steel rails. The heads of these travel fore and aft along the deck in channel irons, mounted on stringer timbers, fastened along the outboard edge of the deck and at the back ends of the drill towers respectively. These rail sections serve as sliding shoes, and their position on adjacent drill towers is alternated, the shoes on alternate towers being both inboard or both outboard of those on the next tower, so that they may telescope underneath the drill frame in the channel-iron track or runway. This permits the drill towers to be moved as close together as 5½ feet, center to center. In other words, holes can be put down from the same setting of the barge as close as 5½ feet. The guides for the drill weights or recoil blocks are 10-inch channels in continuous lengths from the head of the tower to 12 inches below the deck. On the outside forward corner of these channels are attached bracket irons, which carry lengths of 80-pound standard railway rails. These form guides for the telescoping drill pipes used to prevent sand and mud from falling into the drill hole. The drill pipe itself is made of extra heavy steel pipe and can be secured on the bottom in 50 feet of water.

In smaller and in earlier designs of drill boats the drills have been handled on the towers by vertical hydraulic cylinders placed just behind the drill guides and fed by water from high pressure pumps; and a "D" chain, connected at each end to a horizontal hydraulic cylinder, has been used to move the towers along the deck.

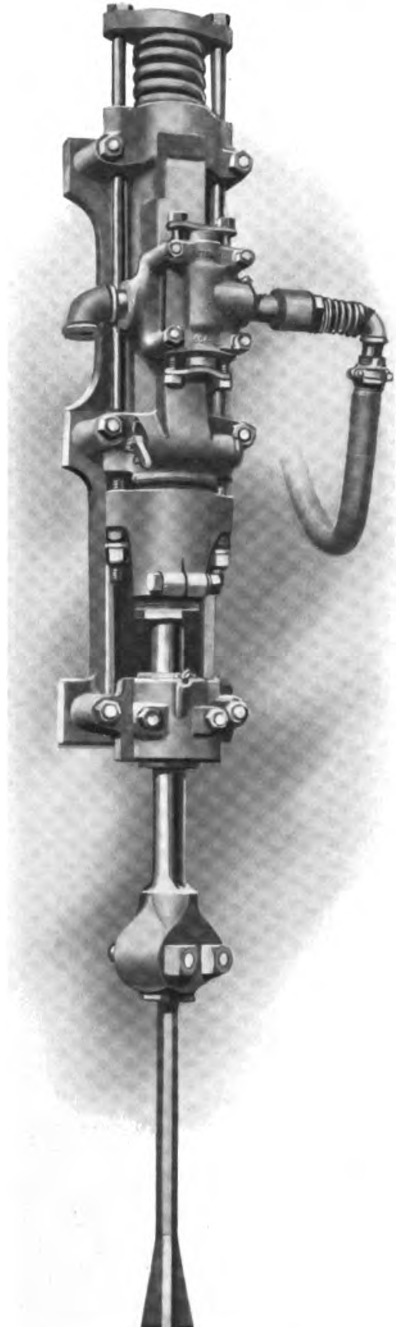
On the "Burrard" the drills are handled on the carriages and the carriages are moved along the deck by what is considered a more modern and desirable method. For this work there are provided five double-cylinder double-drum hoisting engines, one for each carriage. Details of these engines and of their setting are shown in the construction photograph on page 802. Each drum has a winch head, and is provided with brake bands and independent friction. The drill pipe, drill-pipe guides, drill steel, etc., are also handled by these engines. To move the drill carriages along the deck, in order to locate the drill holes correctly, a U-bolt is placed in the deck at each side of each tower. A rope can be hooked to this U-bolt, from which it passes about a sheave in front of the hoisting engine to the drum or windlass head. Heavy setscrews are provided, working in cast-iron clamps, to bind the rail bases of the towers to the channel irons while drilling is going on.

SUBMARINE DRILLS

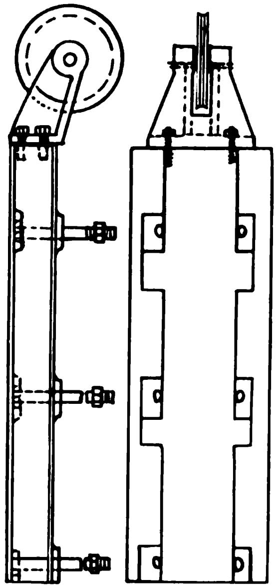
The illustration on this page shows one of the submarine drills themselves, and the sketch on page 806 shows the weight or recoil block, to which it is bolted, and which in turn runs in the channel irons of the drill tower.

The drills selected by the contractor for this work were of the Sullivan submarine pattern, class "FV-14," with cylinders five inches in diameter and extension piston-rod guide. This drill has a length of stroke of 8½ inches, and is capable of boring holes 40 to 50 feet in depth, with a diameter of 2½ to 5 inches. It is the intention, on the present work, to limit the diameter of the holes to three inches. The drill weighs 980 pounds without the mounting, which weighs about 2,000 pounds itself. The drill requires 18 horsepower for its operation.

The valve motion is of the air-thrown differential type, ordinarily used in the regular differential Sullivan rock drills for mining and quarrying work.



Sullivan Submarine Drill, Class "FV-14"



Sliding weight or recoil block for Submarine Rock Drill

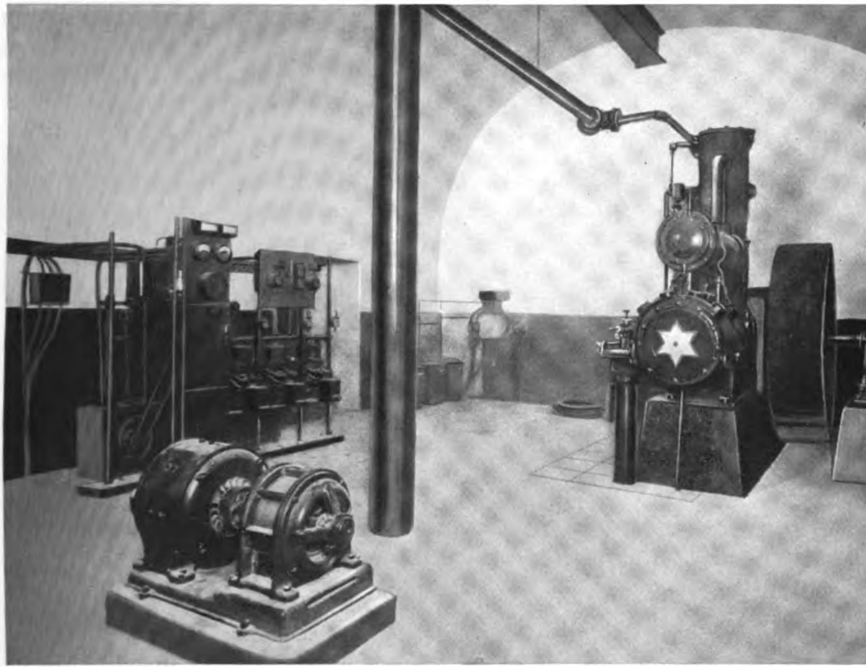
A special feature of the valve motion is the provision of a cushion valve, which effectually prevents the piston from striking either the front or back cylinder head when operating under wide open throttle. This permits the machine to run at practically full speed, in starting a hole, in broken rock or on a sloping surface. It also greatly aids the work of restoring a deflected hole to proper alignment. This valve may be used to advantage in pumping out a hole that has become clogged with mud before loading it for firing. It is held in position normally by a spring, and a cord or small chain can be attached to the valve lever, so that when the drill is operating beyond the reach of the operator, this lever may be thrown forward by pulling on the cord. This lever is shown in the photograph, on page 805, near the lower end of the cylinder.

To prevent cylinder wear, a lower guide bearing is provided for the piston rod. This is in the form of a channel-shaped extension from the cylinder proper, which supports at its lower end a removable bronze bushing in which the piston rod moves up and down. The drill is oiled automatically by the standard Sullivan differential pressure lubricator. This consists of a chamber in the cylinder wall, from which the variations of the steam pressure in the chest force oil at intervals into the chest, where it is vaporized and carried through the chest and cylinder in the form of a spray.

These machines are very heavily made and are strong and powerful, for performing properly the heavy duty required of them. As stated above, they are bolted to a heavy backing plate or recoil block, shown in the sketch on this page. This block is provided with a sheave at the top to facilitate handling it on the cable from the hoisting engine. This cable runs over double steel sheaves at the top of the drill tower. Steam at 120 pounds pressure is furnished the drill through sliding joint steam piping. The drill supply pipe is 1½ inches in diameter. From the point at which the steam-supply pipe reaches the outside of the vertical drill channel iron it is carried to the drill cylinder, as the latter is moved up and down the tower, by a telescoping pipe of the usual character.

This drill boat was designed throughout by Mr. A. F. Woolley, member of the American Society of Civil Engineers, and consulting engineer for Henry, McFee & McDonald. The hull was constructed at the Wallace ship yards at Vancouver; the pumps by the Worthington Company, and all the engines and drill towers and spud trusses by the Marion Osgood Company, of Marion, Ohio, from detailed information furnished by the consulting engineer.

The writer is indebted to Mr. Woolley and also to Mr. Mark Odell, Manager of Henry, McFee and McDonald, for information contained in this article and for assistance in securing the photographs.



Underground Air Compressor Station of Silver King Coalition Mines Company, showing Sullivan Angle Compound Compressor

AN UNDERGROUND COMPRESSOR AND HOIST STATION

By H. E. Moon *

An underground air compressor and hoist station, whose size and importance are unusual in American practice, is now being completed in the Silver Hill section of the property of the Silver King Coalition Mines Company, Park City, Utah. The Park City district is located about thirty-five miles southeast of Salt Lake City.

For the proper development of this section of the Silver King property it became advisable to sink a shaft from 1,200 to 1,300 feet in depth at a point about two miles in from the mouth of the Alliance tunnel. This point is under 1,600 feet of cover, and corresponds in elevation with the 500-foot level of the main King shaft, through which the principal operations of the company have been carried on thus far. The proposed shaft will be cut through to the quartzite contact, underlying the ore body that is now being worked, through the King shaft, at a depth of 1,300 feet.

In order to provide hoisting and compressed air service for the new shaft, the company decided to construct an underground station in the solid rock. This station is one of the largest of the kind in this country, and the work which it will be called upon to do is more important than has been undertaken elsewhere from an underground station. There are three rooms or chambers; first, a compressor room, 42 feet long, 30 feet wide, and 20 feet high. The roof arch of

* University Club, Salt Lake City, Utah.

this room is elliptical, and all the walls, as well as the roof, are of heavy reënforced concrete, designed to support the heavy top of badly broken lime rock. Adjoining the compressor room is, second, the engine room, 42 feet long, 35 feet wide, and rising in height from 12½ feet at the back toward the shaft, at which it is 24 feet high. These rooms are finished with smooth white cement plaster and are well lighted by electricity. Third; the remaining chamber is that excavated for the head frame. This is sufficiently large to accommodate the steel frame, 38½ feet high from the foundation to the center of the sheaves, with a spread of 25 feet from front to back, and a width of 28 feet. The distance from the center of the shaft to the center of the hoist reels is 43 feet.

A first motion, double-reel hoisting engine has been installed, driven direct by a 200-H.P. motor, running at 65 R.P.M. and taking direct current at 600 volts from a motor generator set located in the compressor room.

"ANGLE COMPOUND" AIR COMPRESSOR

Air for the tunnel, shaft and construction of the station has been supplied by three large air compressors on the surface, which also furnish air for the King shaft and its workings. It was considered advisable to install an auxiliary compressor in the underground power station, to act as a booster on the main line, and ultimately to give regular additional capacity for sinking the shaft and developing the new workings below the tunnel level. The machine selected for this purpose, particularly on account of its compactness and high air capacity per unit of floor space, was a Sullivan class "WJ-3" ANGLE COMPOUND compressor, with low-pressure cylinder 18 inches in diameter, high-pressure cylinder 11 inches in diameter, and a common stroke of 14 inches. At its rated speed of 215 revolutions per minute, this machine has a displacement capacity of 886 cubic feet of free air per minute. As shown in the illustration, the ANGLE COMPOUND compressor is arranged with the low-pressure or intake cylinder in a horizontal plane and the high-pressure cylinder set vertically on the end of the horizontal frame. Both pistons are actuated by a single crank, and both sets of valve gear by a single eccentric pin. The connecting rods take their motion from the same crank pin, on which they are set side by side, this arrangement being made possible by the fact that the center lines of the two cylinders are slightly offset from each other; that is, are not in the same plane.

The driving pulley, for this machine is operated by belt, is mounted at one side, on an extension of the crank shaft, having an outboard bearing. The economy in floor space, foundations, and drive room of this type of compressor will be very evident. It may be direct connected to a motor or water wheel, or furnished with a belt-tightener for short belt drive, if necessary.

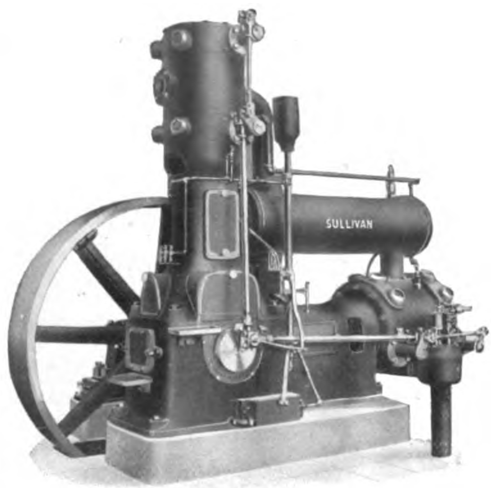
Other notable features of this machine consist in its accessibility, low foundation and installation cost and the fact that in the ANGLE COMPOUND compressor the unbalanced effects of the horizontal members are offset by those of its vertical members, the result being that a very smooth action of the entire machine is obtained at relatively high speeds, and with very little strain on the base and foundations.

The idea of the engineers in designing this plant was to have the compressor utilize the electric current during the intervals when the hoist was not running, thus eliminating excessive peak loads. To accomplish this, the compressor unloader is connected with the hoist, so that when current is thrown into the motor of the latter, this action automatically unloads the compressor, and allows nearly the entire power of the synchronous motor set to be available for the hoist motor. When the hoisting current is thrown off, the unloader on the compressor is auto-

matically opened, allowing the machine to work under full load again, thus providing a high load factor for the motor generator set, as well as a nearly constant current demand. This synchronous motor generator set furnishes direct current at 600 volts for the hoist, and the motor of the set takes current from the transmission lines on the surface at 2,200 volts A. C., with a rated continuous input of 250 KVA, and having 80 per cent power factor. A motor generator exciter set furnishes direct current excitation for the large synchronous motor of the large set.

There is abundant room in the compressor station for the addition of three to four other units of the same type, should greater compressor capacity be desired later on.

The Silver King Coalition Mines Company has 2,400 acres of mining ground, and is a producer of silver lead zinc ore. It is incorporated for $6,250,000.00 in $5.00 shares, and thus far the property has paid over $13,000,000.00 in dividends.



Sullivan "WJ-3" Air Compressor

We wish to acknowledge the courtesies extended in the work of getting the information and pictures contained in this article by Mr. James Humes, in charge of the property, Mr. James Toole, master mechanic, by Messrs. Wilson & Ott of Salt Lake City, who designed equipment for the station, and to the "Salt Lake Mining Review," whose issue of November 30, 1913, gives a very complete description and report of this entire property.

RECORD DEPTH FOR A HAND POWER DIAMOND DRILL

The following report is offered as constituting a record for the Class "M" hand power diamond core drill. The rated capacity of this machine is 350 feet, removing a core 15/16 inch in diameter. It is fair to say that in this case the drill was not operated by hand power but by steam. But the record is nevertheless remarkable for a drill of such light design.

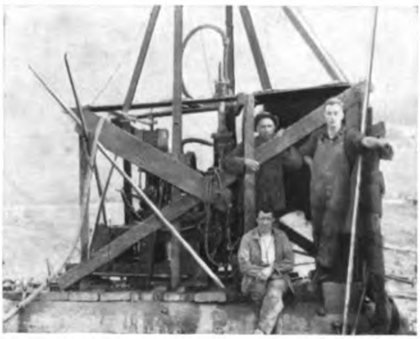
The total depth of the hole bored was 1182.5 feet. This work was completed in about six months; namely, from June, 1896, to December, 1896. Power was supplied by belt from a steam engine, and the rods were raised and lowered by means of a "crab" or "niggerhead" attached to the engine. The rods were not counterbalanced while drilling.

This hole was bored on the Arnold farm, near South Canaan, Pennsylvania, in Wayne County. The depth of the overburden, or surface deposit, through which stand piping had to be driven, was 161 feet 2 inches, and the record was the more remarkable because the machine was the old type of "M" drill, with single ball-bearing.

The work was done by Mr. John Scism, D. W. Scism, foreman, and it is interesting to note that this same drill is still in use by Mr. Scism.

BORING BLAST HOLES WITH A DIAMOND DRILL

By W. R. Austin*



Sullivan Diamond Drill at Tenino

It is seldom, nowadays, that diamond core drills are employed for any but their legitimate purposes, namely, mineral prospecting and test drilling, in which the core recovered is all-important. Occasionally they are used for special purposes, such as that of tapping bodies of water under pressure in mines. Thirty years ago diamond drill gadders and channelers were considered the most satisfactory means of quarrying marble, but the increase in cost of black diamonds since that time has precluded any regular use that does not utilize the core records.

The drilling of deep blast holes in a quarry by this means, therefore, sounds incongruous and extravagant to those familiar with excavation methods and costs. But that is just the work for which the Hercules Sandstone Company is using a diamond drill at Tenino, Washington. This company has a contract to supply stone for a United States government jetty, under construction at Gray's Harbor, which is between Tacoma, Washington, and Portland, Oregon. Rock fragments or boulders of large size are required for this work. The quarry face is about 70 feet high. The method at first used consisted in drilling "coyote" holes horizontally at the base of the cliff. This resulted in shattering the rock badly and breaking much of it too small for use, thus causing a high operating cost.

During the fall of 1913 the company installed a Sullivan class "C" diamond core drill, with "A" fittings, boring a hole 1$\frac{11}{16}$ inch in diameter and normally removing a 1⅛ inch core. With this drill holes are bored to an average depth of 63 feet, 30 feet back from the face, and nine feet apart. After boring the hole, a special tool is run down, cutting a groove on each side, in line with the line of holes. These grooves aid in splitting the rock, which has a favorable grain, from one hole to the other. The holes are sprung with dynamite and then loaded with black powder to about ten feet from the top. When shot, the whole face is thrown over into the quarry and breaks into very large pieces.

The average progress by the diamond drill has been about 53 feet of hole per day, which indicates the favorable character of the stone. The cost of drilling and grooving together is given as 28 cents per foot. The wear on the diamonds is practically nothing.

A blast of sixteen holes, made soon after the drill was installed, threw about 40,000 tons of rock. Others, made later, produced an even larger amount of stone. The first

Hercules Quarry after a blast

*Hutton Bldg., Spokane, Wash.

figure gives a drilling cost of $7.00 per thousand tons of rock excavated, or 2½ cents per cubic yard.

The photographs on page 810 show the drill, which was operated by compressed air, and the rock after blasting, showing the large size of the fragments. At the left may be seen the quarry face, with the lines of some of the drill holes. The drill is mounted on skids on which it is pulled from one hole to another by a cable and hoist.

The Hercules Sandstone Company owns several channeling machines, including a Sullivan class "6½," for quarrying dimension stone.

NOTES ON AUSTRALIAN COAL MINING

By Matt Brodie and P. T. Milligan*

THE STATE MINES AT WONTHAGGI, VICTORIA, AUSTRALIA

At Wonthaggi, Victoria, Australia, the state government owns and operates extensive coal mines, which are under the direct management of the Railways Commission in that state. These mines were opened in 1909 and now rank third among Australian producers of coal. They have supplied nearly the whole of the fuel required by the State Railway for three years past.

The state coal property covers an area of 5,100 acres. About one-half of this has been very thoroughly prospected with test drills, and has been shown to bear coal ranging from 2½ feet to six feet in thickness. The drills employed for this prospecting work were of the diamond core drill pattern, owned by the Victoria State Government, one of them being a class "H" 1,000-foot Sullivan hydraulic cylinder machine. Since the beginning of this work, nearly 400 bore holes have been put down. During the two years ending June 30, 1913, 27,500 feet of core borings were performed, in 104 bore holes, with an average depth of 264 feet.

The boring done during the last year proved that a lower seam of coal of workable thickness underlies a considerable area of ground north of the present workings. This discovery has increased the estimate of the quantity of coal, 30 inches thick and over, in the mine area, by some 1,500,000 tons, making a total estimated quantity in the area of 28,000,000 tons. Allowing 20 per cent for loss in working, and deducting 1,434,000 tons, already extracted, the total still available for production is about 21,000,000 tons. The core borings are being continued to prove the remainder of the ground.

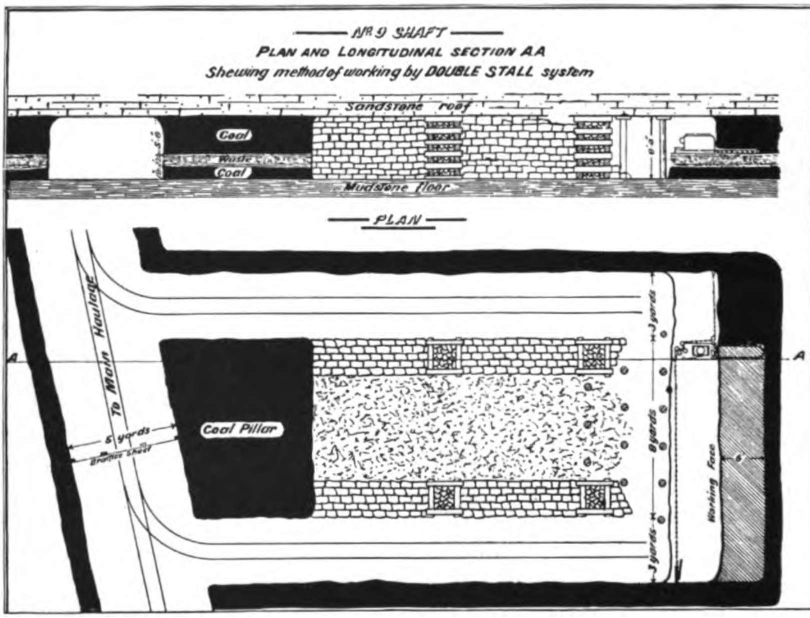
The report of George H. Broome, General Manager at Wonthaggi, for the year ending June 30, 1913, has recently been received. It is very complete and a model for such reports. The balance sheet shows a net surplus profit for the year of about $207,000.

SIX HUNDRED AND FIFTY ACRES DEVELOPED

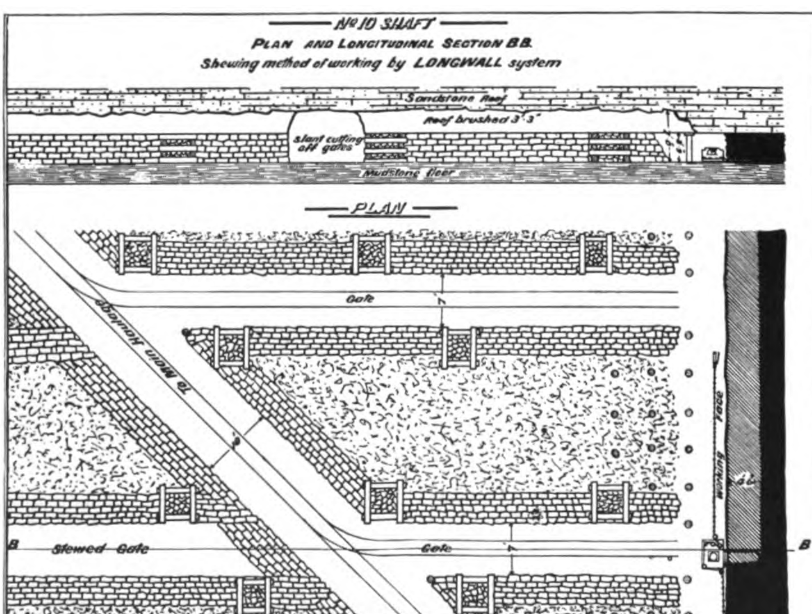
The present workings cover an area of about 650 acres, developed by twelve shafts, all of which work the originally discovered or upper seam, which is about 235 feet from the surface. The coal varies from 2½ to six feet in thickness, and is very irregular, the entire area being badly broken up by faults. The roof ranges from sandstone to soft shale, and even to material much broken and as soft as mud. The changes occur very sharply, making the problem of mining and of sustaining the roof a very difficult one.

The output of the mines is hoisted from three shafts, Nos. 5, 9, and 10. There is but one tipple and coal handling plant; namely, the one at No. 5, which was enlarged during the past year to handle the entire output of the three mines. The coal

* Australasia Chambers, Sydney, N. S. W.



Plan of Workings at No. 9 Shaft; Room and Pillar System



Plan of Workings at No. 10 Shaft; Longwall System

from from shafts No. 9 and No. 10, some 450 feet distant, is conveyed above ground to this point by means of an electrically driven endless rope.

PRODUCTION AND LABOR

The gross tonnage for the year was 462,558 tcns. Of this amount, 258,249 tonswere screened, 9,239 tons unscreened, and 190,163 tons slack coal — a total of 457,651 tons shipped, of which all but 17,000 tons of screened coal was furnished to the State Government Railway. Ten thousand six hundred tons were furnished to various public departments and 171,000 tons of slack coal only were disposed of to the public. The average number of employés during the year was 939, comprising 468 coal miners, 250 other miscellaneous underground employés, and 221 surface men. The mine worked 260 days during the year, on a basis of two shifts.

The average earnings of the miners were $3.23 per day, after deducting the cost of explosives and light. There was but one fatal accident during the year, this being due to a fall of coal at the working face. Underground miners are paid chiefly on a tonnage basis.

MINING METHODS

The illustrations on page 812 indicate two typical methods of mining at Wonthaggi, although, as stated above, the great irregularity of the seam makes it difficult to adhere to a given system, as the work progresses from one part of the mine area to another. The sketches show the characteristic methods of working at No. 9 and No. 10 shafts. At present these two shafts are producing about one-half the output of the mine, and practically the whole of this coal is being mined by coal-cutting machines of the Sullivan electric room-and-pillar and longwall patterns. The upper sketch shows the method of working in No. 9 shaft, where the coal is about 6½ feet high, with a 22-inch dirt band, 18 inches from the floor. As indicated, the method of working is by "double stall," with stalls or rooms 42 feet wide, and two gates, or, as they would be called in this country, room necks, with a track in each.

The coal is first mined with a Sullivan room-and-pillar machine, class "CE-7," on the top of the dirt band, the depth of undercut being six feet. The upper five feet of coal is then shot down and filled away or loaded. The dirt band is next lifted and thrown back into the gob; and lastly, the lower 18 inches of coal is raised and loaded out.

In No. 10 shaft working, where the coal is much lower, averaging about 3 feet 9 inches in thickness, the longwall method is in vogue. A gate or entrance seven feet wide is provided every 33 feet for handling the machine and loading out the coal, the space between being filled with pack to support the roof.

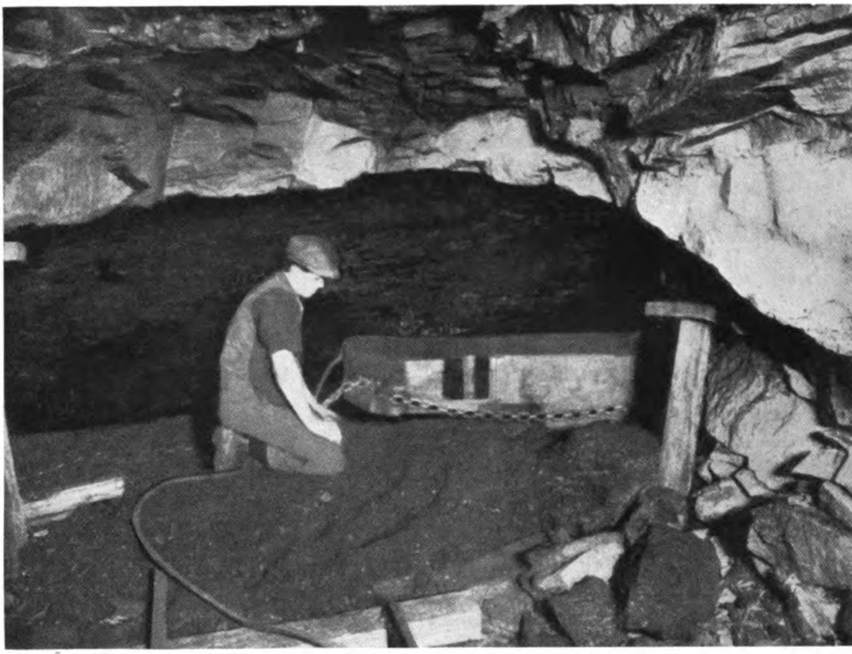
The broken nature of the seam is shown by the picture of a Sullivan longwall machine in operation at No. 5 mine. Where the machine is, the coal is three feet high. A few feet away to the right and left it is but 18 inches thick. The operator shown in the picture is Mr. P. T. Milligan, the author of the second portion of these notes.

NEW DEVELOPMENTS

A new opening or slope, known as the McBride Tunnel, is being driven at a gradient of 1 in 5½, for the development of the area lying to the north of the present workings. It is now several hundred feet in from the entrance, and its object is to cut four successive down-throw faults in the present known seam. This will enable the coal to be extracted from four different levels in about three-quarters of a mile of tunneling. The objective point of the tunnel is the lower seam of coal mentioned above, in the northern portion of the area.

SURFACE PLANT

The mines are equipped with the most up-to-date machinery, on the surface as



Sullivan Longwall Electric Mining Machine in No. 5 mine, Wonthaggi, Victoria

well as underground. The total value of the plant is nearly $1,000,000.00. Electric hoists are employed to raise the coal at the three present working shafts. Electric power for the hoists, coal mining machines, rope hauls, pumps, fans, etc., is generated from a central station, which includes a battery of eight boilers fitted with underfeed stokers for burning slack, two generating sets driven by reciprocating engines, and a horizontal turbo-alternator. Current is generated at 5,200 volts. The electric power is distributed from this plant to the different mines, where transformers and rotary converters are located, for operating the coal-handling machinery, screens, hoists, tipples, etc.

At the No. 9 and No. 10 shafts a change house and bath rooms were provided for the workmen during the past year. The building is of wood and corrugated iron construction, with a concrete floor, and accommodates 400 men. Forty shower baths are provided, with an ample supply of hot and cold water. The workmen's clothes are dried by steam heat. They are attached to hooks, which are handled by chains passing over pulleys on the rafters, so that they may be raised into position for drying.

Mr. Broome's report for 1912 stated, in regard to the Sullivan coal cutters:

"These machines are working very satisfactorily on the longwall faces, where the coal is from 2 feet 6 inches to three feet in thickness. Under these conditions they are effecting a saving in cost of about one shilling per ton, compared with hand mining, and in addition to this saving recent tests have shown a reduction of ten per cent in slack, from the machine faces, which at the present selling price means an increase of over 5 pence per ton in the value of the product."

During that year three machines were in use. During the year ended June 30,

1913, eleven Sullivan machines were in operation, and the 1913 report states:

"The larger use of these machines has tended to reduce operating costs and to improve the product by reducing the percentage of slack."

In all, the Wonthaggi mine now owns about 25 Sullivan continuous coal cutters, of which 17 are of the longwall pattern.

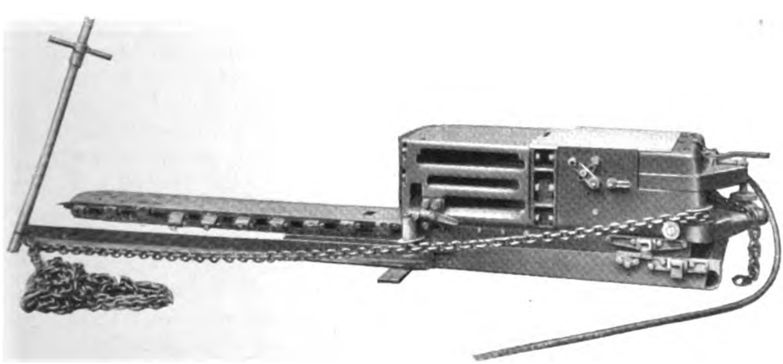
The 1913 report shows that these state-owned mines are hoisting 2,200 tons per day of two shifts.

MOUNT KEMBLA COLLIERY

While there are many American coal cutters of the Sullivan continuous cutting pattern in use in the various Australian mines, the following mention is of particular interest, because the machines concerned are of the new alternating current IRONCLAD pattern. Three of these machines are in operation at the Mount Kembla colliery, South Coast, New South Wales, Australia. The average cutting of these machines is about five places per shift, including 5-yard headings and 8-yard rooms or bords. An interesting feature of mining at this colliery is that of cutting the coal on canches (benches). This is due to the frequency of rolls of hard stone in the floor of the mine. These rolls are ordinarily quite gradual, and it is customary to drive the rooms along the floor of the trough, causing the crest of the roll to come in a pillar wherever possible. Where the rolls are sharper, varying in height from 18 to 24 inches above the regular level of the floor, the canches are worked ordinarily about 30 inches above the regular floor level. The total thickness of the seam, it may be stated, is about 6½ to 7 feet, and it is nearly flat.

In order to operate on these canches or benches, the Sullivan IRONCLAD machines are mounted on special trucks, raised to a height of 2 feet 9 inches above the floor. These are built up by two pieces of 12-inch "I" beams, placed horizontally between the wheel base frame and the truck frame. The canches are carried about the depth of one machine cut, namely, 6½ feet back from the face, so that when the coal is blasted down after undercutting, most of it remains on the canch, from which it is loaded direct into the mine cars, thereby saving the labor of lifting the coal from the floor to the top of the car. An individual miner can fill as high as twenty tons in a shift off one of these benches.

Before the continuous cutting Sullivan machines were installed, American breast machines had been tried and the greater length of the breast machine made it necessary to keep the canch or bench much farther back from the face than is now the case; namely, from 15 to 20 feet. It was, therefore, necessary to handle the coal



Sullivan Ironclad Alternating Current Chain Coal Cutter, and Sumping Bar

twice; the face shovelers throwing it back to the edge of the canch, from which point it was loaded into the cars.

With the new alternating current IRONCLAD machine the cutting speed in this mine averages 16½ inches per minute, and the average load taken is 40 amperes. In some parts of the mine, where the rolls are gradual, the machine follows them, and the canch system is not necessary.

The IRONCLAD machine is driven by a 30 H.P., 3-phase, 440-volt, 60 cycle, squirrel-cage induction motor, with a Star-delta controller for starting. The motor is gas proof. The advantages of using alternating current at this mine are enhanced by the fact that it is 2¼ miles from the tunnel mouth to the working face, so that much higher efficiency is secured in transmission than would be possible with direct current.

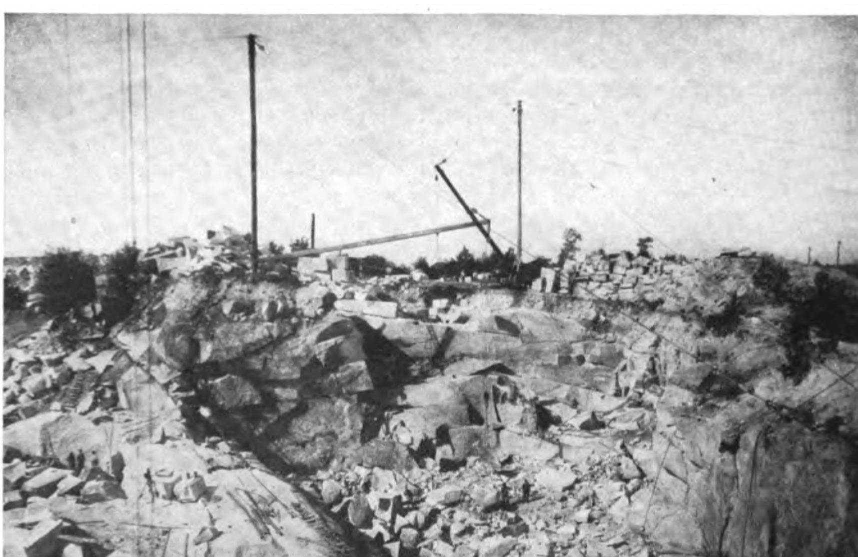
COMMEMORATING PERRY IN MASSACHUSETTS GRANITE

BY R. P. HUND[1] AND G. H. RICHIE[2]

With the beating of drums, the blare of trumpets, red fire, speech making, friendly competition on land and water, and other accessories which go to make an enthusiastic celebration, the one hundredth anniversary of Commodore Oliver Hazard Perry's victory on Lake Erie was last summer fittingly observed in the cities and towns along the lake shore.

While this form of celebration is forgotten almost as soon as finished, the magnificent Perry monument, now being erected at Put-in-Bay, facing the scene where the Battle of Lake Erie was fought, will last for ages as a commemoration of that victory and of the one hundred years of peace between Great Britain and the United States.

[1] No. 1 Madison Ave., New York City. [2] 35 Federal St., Boston, Mass.



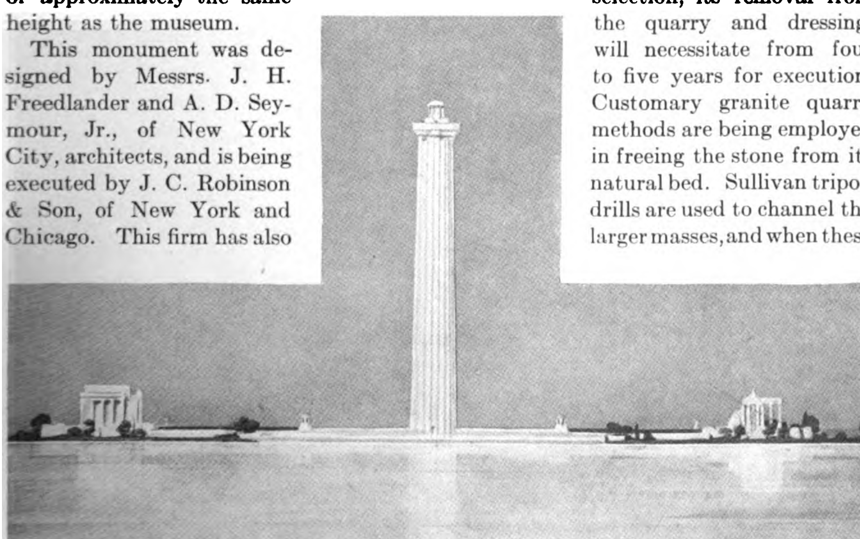
Quarry of the Massachusetts Pink Granite Company at Milford, Mass.

This magnificent monument will cover an area of approximatey 750 x 460 feet. The Doric column in the center, shown by the accompanying illustration, is 335 feet in height from the base to the light on the tripod. The column is 45 feet in diameter at the base and 35 feet at the top. It is stated that this is the highest monument in the world, with the exception of the Washington monument at the National capitol, and the highest column, without exception. On the capital of the column an observation platform is provided which will be reached by an electric elevator from the base of the column. The column stands alone, so that it may be seen over the water from all points, and on one side, distant about 300 feet, is being erected the museum, in which books, paintings, engravings, firearms, and other relics, which pertain to the period of the Battle of Lake Erie and of the War of 1812, will be on exhibition. On the other side, and also 300 feet distant, will be erected a statue typifying "Peace by Arbitration," which will be enclosed on three sides by a colonnade, of approximately the same height as the museum.

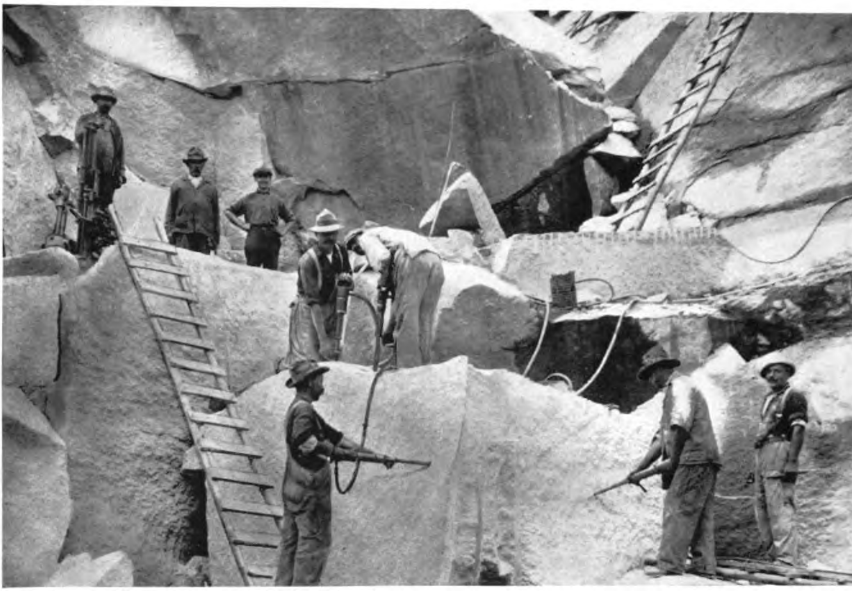
This monument was designed by Messrs. J. H. Freedlander and A. D. Seymour, Jr., of New York City, architects, and is being executed by J. C. Robinson & Son, of New York and Chicago. This firm has also to its credit the great cathedral at St. Louis and the classic Columbus Memorial at Washington, D. C.

The stone selected for the entire memorial is of the white granite, found at Milford, Massachusetts, exceedingly beautiful in texture and of a sufficiently delicate pink cast to temper the white and to counteract the natural tendency of pure white stone to take on a bluish appearance under the sky. Technically it is known as Milford Pink Granite, and was especially selected on account of the perfection of its geological composition, after exhaustive mechanical tests for hardness and durability. The latter quality is naturally an essential in the choice of material for a monument destined to last through the ages.

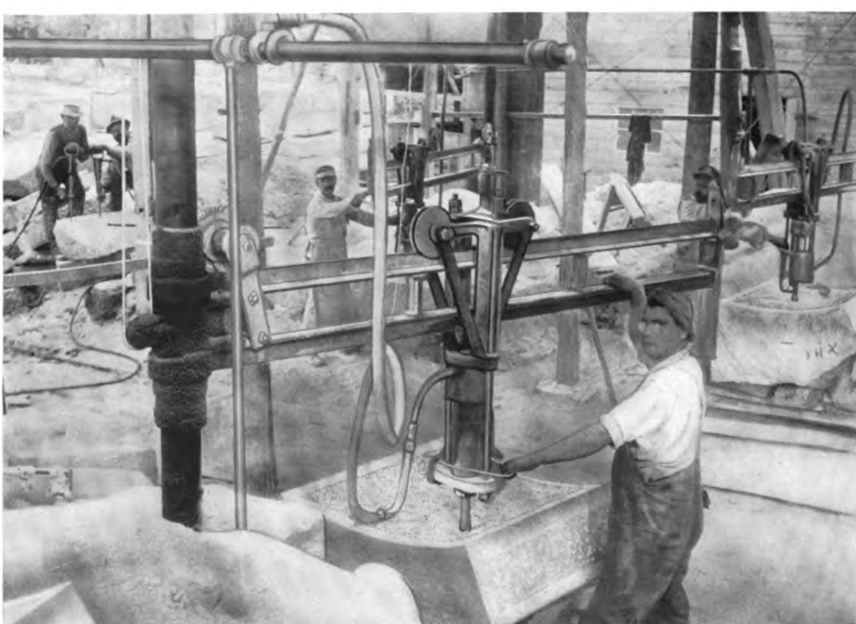
All of the stone for this work is being furnished by one concern at Milford, the Massachusetts Pink Granite Co. The accompanying illustrations were taken at the quarries of this company, particularly for Mine and Quarry. The amount of stone required for this large enterprise, the care necessary in its selection, its removal from the quarry and dressing, will necessitate from four to five years for execution. Customary granite quarry methods are being employed in freeing the stone from its natural bed. Sullivan tripod drills are used to channel the larger masses, and when these



The Perry Memorial Monument, at Put-in-Bay, Ohio, as it will appear when completed



Splitting granite at Milford with Sullivan Plug Drills, for the Perry Memorial



Sullivan Surfacing Machines dressing granite, for the Perry Memorial

are freed they are split up into the sizes desired by means of about thirty Sullivan class "DA-15" plug drills, and are then dressed and finished with an equipment of four surfacers, also of Sullivan manufacture.

The work done in splitting granite by means of the Sullivan plug drills and plugs-and-feathers is extremely rapid and accurate. The drills put in holes approximately ⅝-inch in diameter, to a depth of three inches, and on rush work, have drilled from 125 to 160 of these holes in an hour. A special cushioning device, incorporated in the valve motion of these tools, reduces the jar and vibration, and with it the fatigue to the operator, which would otherwise be a disadvantage in such a rapid working tool.

Among other monuments in which stone from the Massachusetts Pink Granite Company's quarries has been used are the McKinley monument in Canton, Ohio, and the "Maine" monument in New York City, as well as many office and public buildings.

Modern methods used in hauling granite at Milford

THE DIAMOND DRILLMAN'S LOG — A DIFFICULT DEEP HOLE

A diamond drill prospecting hole was put down near Taber, Alberta, Can., during the past year, which was remarkable for the depth of the boring, and more particularly for the difficulties encountered in the work. This hole was 3,003 feet in depth, and the size of core at the bottom of the hole was 1⅛ inches. There are at least two core drill holes deeper than this in North America, one 3,200 feet in depth, on the property of the American Development Company, near Bisbee, Ariz., and one 3,265 feet deep, bored near the American Mine, Republic, Mich. The first of these holes was bored with a Sullivan "C" drill; the second, with a Sullivan "B" drill.

The hole at Taber encountered tremendous difficulties, due to the presence of soft and caving ground, instead of solid rock, particularly at great depth, and its claim to a record is due to the fact that these difficulties were overcome, and the hole finished to the specified depth of 3,000 feet; and also to the amount of drilling material required to put this hole down. Including the various sizes of casing, rods, etc., the total amount of drilling material required to bottom the hole at 3,003 feet was 10,528 lineal feet, distributed as follows:

6-inch standpipe	50 feet
4-inch casing	1,875 feet
3-inch casing	2,700 feet
2-inch casing	2,900 feet
Class "A" drill rods	3,003 feet
	10,528 feet

This work was done under contract by the Sullivan Machinery Company, with a Sullivan class "P" hydraulic feed drill. H. R. Parsons was the foreman in charge of the work.

TAPPING WATER WITH DIAMOND DRILLS

By J. I. Edwards* and D. J. Tynan**

Peons Moving a Sullivan Diamond Drill in the Mexican Mountains

The use of diamond core drills for tapping large bodies of water, in underground mine or tunnel workings, for the purpose of draining them or of relieving pressure, is not a new one, and has been employed in numerous isolated cases, with great success.

The following description of work of this character in Mexico is interesting on account of the fact that diamond drills were used for this work exclusively and systematically over a period of months; and further, that without this use of diamond core drills a great engineering project would have been seriously delayed at least, and forced to change its entire plans at greatly increased expense.

The diamond drilling work referred to was performed by Messrs. Jacobs and Davies, Inc., of New York and Mexico City, contractors for the construction of the hydro-electric plant of the Mexican Light & Power Company, at Necaxa, State of Puebla, Mexico. The Necaxa power plant is probably the most important one in old Mexico. Here some 90,000 electric H.P. are generated and transmitted to various points in the surrounding country, including the great silver camp of Pachuca, in Hidalgo, and El Oro, in the state of Mexico, the well-known center of gold mining, which draw practically all of their electrical power from this source. Mexico City and the Federal District, ninety-five miles away, employ Necaxa electricity very largely for lighting, factory use, and tramways. Power for El Oro is transmitted first to Mexico City, and seventy-five miles farther to El Oro, making a total distance of 170 miles.

While the volume of water involved in these large Mexican hydro-electric systems is not so large as that available for similar use elsewhere, the heavy rainfall and mountainous nature of the country provide unusually high heads, which make up for the smaller volume. It is, however, a great problem to secure sufficient catchment area to enable these plants to operate at full capacity the year round.

To prevent a shortage, the Mexican Light & Power Company have now completed an elaborate system of tunnels and dams. In the development of this supplementary system, about twenty-five tunnels, totaling some twenty-five miles, have had to be driven. These vary from a few hundred feet to several miles in length.

Work on this system has been retarded by the difficulty of driving tunnel No. 1, at San Lorenzo, in Puebla. This tunnel is the connecting link between the twenty-five mentioned above, that drain the country between Zacatlan and Huachi-

*Aledo, Illinois. **Pachuca, Hdgo., Mexico.

nango, and the dams of Nechapa, Tenango and Necaxa. It passes through a mountain composed of a mixture of large and small boulders, volcanic ash, clay, sand, and gravel. The whole mountain was heavily charged with water both on the surface and underground, mixed with the various deposits, or in larger bodies. This water caused the tunnel to be lost on four different occasions. Whenever the tunnel approached or passed near a body of water the pressure became very great, and the sand, gravel, and ash, with the enormous pressure behind it, would ooze out between the tunnel timbers, in some cases breaking timbers 10x10 inches in size, and on one occasion at least filling the completed tunnel with four thousand carloads of muck.

It was at this stage, when the completion of the tunnel seemed to be impossible, that diamond drills were installed. There were four of these drills, all of Sullivan manufacture; two being the "Beauty" screw-feed pattern, with a capacity of 800 feet in depth, which were used underground, and two being class "H," with hydraulic cylinder feed, and a capacity of 1,000 feet in depth. These "H" drills were used especially for preliminary test borings, as will be described later.

Sullivan Diamond Drill set up for surface work

UNDERGROUND DRILLING

When indications of pressure occurred in the tunnel, a "Beauty" drill was set up to tap the water, relieving the pressure by draining it away, thus allowing the tunnel to proceed with safety. Sometimes the water appeared on the face, sometimes on the sides or above the tunnel, and on one occasion, in the roof of the tunnel, about twenty feet back from the tunnel head. It was necessary, in this case, to drill three upper holes at an angle of 45 degrees, to a depth of 25 feet each, where the water was reached and drained off. The horizontal drilling in particular was attended with many difficulties, owing to the disturbed and broken character of the ground. Holes were usually started 2½ inches in diameter, using a 2½-inch diamond bit, and 2½-inch casing as drill rods. The vibration of the rods loosened large and small boulders, causing much trouble, when withdrawing the bit. In many cases the rods were jammed, so that it was necessary for several men to keep the rods constantly turning with Stillson wrenches. This work could almost be described as "diamond drilling without a drill hole;" for at least four-fifths of every horizontal hole had to be redrilled ten or a dozen times, since the hole would cave in as soon as the bit was withdrawn.

Usually the 2½-inch casing was drilled in to a distance of 50 feet, from which point the hole was continued with an "E" casing bit, finally bringing the cuttings down to size "E" rods and bits, removing a 15/16-inch core. Two hundred feet was an average depth for these holes, although water was frequently

struck sooner. Great care had to be exercised, while drilling, to keep the water running and the rods revolving, otherwise the caving material would bind and jam the rods as effectively as if they were cemented in. The actual drilling was not difficult, as the rock was not hard.

On one occasion a body of water was met thirty-five feet ahead of the tunnel face, which drained for twenty-four hours through a 2½-inch casing, and even then showed a pressure of 24 pounds per square inch. Three 2½-inch holes were drilled across the tunnel head to drain this water. One of these went to a depth of 300 feet, 200 feet of which was drilled in fifty hours with an "E" bit, without once withdrawing the rods.

SURFACE DRILLING

The two Sullivan "H" drills were used for putting in prospect holes to locate favorable ground for tunneling, from the surface of the mountain, following the tunnel line, across country almost inaccessible on account of the thickness of the trees, undergrowth, and the steep and broken nature of the ground. The drill sites ranged from 500 to 800 feet above the tunnel level. While the upper half of the mountain consists of a cap of tuff, hard and flinty on the outside, the material beneath the surface is soft, and about half way up the mountain, this rock gave way to a mixture of decayed vegetation and soil. To the difficulties of drilling in this formation were added those of moving the outfit and cutting trails.

This trail, in places scarcely two feet wide, had to be made along the edge of precipices, and through dense forest growths. Peons were used altogether in moving the drills, as shown in the photograph on page 820. Twelve to sixteen peons would carry an "H" drill along trails where a slip meant a drop of 100 feet.

The drill sites were in some cases so steep, being cut out of the rocky mountain sides, that the top of the tripod was not over 10 feet from the rocky wall.

A Mexican *cabo*, or boss, and thirty peons were kept constantly at work, cutting trails and drill sites.

The drills were operated by compressed air, supplied through a three-inch pipe three-quarters of a mile long, which connected one of the shafts with the compressor room. This passed at an average distance of 1,000 feet from the tunnel line, and from this a 1½-inch supply line was run to the drills. Water for drilling, pumped from the river, was raised by two triplex electric pumps, and 7,000 feet of air and water line were used exclusively for diamond drilling purposes.

Falling rock and Indian wood cutters occasioned much trouble by breaking the three-inch pipe line. On one occasion a drill runner was working the rods through 120 feet of sediment, when this occurred, causing the power to be shut off suddenly, and permitting the loose ground to settle around the rods, causing the loss of the bit. When the power supply was resumed some four hours later, the sediment had set so tightly that the rods could not be moved by either jarring or jacking. Reaming was out of the question, since there was a line of 500 feet of two-inch casing in the hole, which it was also impossible to pull. The hole in this case was continued by deflecting it 100 feet above the stuck bit. This was a sample of the difficulties encountered.

In another instance the rods were loosened by sawing a coupling so as to weaken it, and then jacking the rods until the coupling broke. The recoil of the rods loosened the bit, and permitted their final recovery. The holes ranged in depth from 500 to 800 feet. Much of this drilling was accomplished with a chopping bit of the cross pattern, one blade being 1½ inches longer than the other, enabling the hole to be kept true and round. With this bit, as high as 60 feet of drilling were accomplished in eight hours' work.

As the work of these drills was partly intended to indicate the character of material on the tunnel line in advance of

driving, a double-tube core barrel was used to obtain an accurate record on the tunnel level, and in spite of the loose and broken character of the ground, about seventy-five per cent of core was obtained with this device.

Altogether about 7,000 feet of drilling was performed on the tunnel line, the cost of which was very light considering the difficult nature of the work. The diamond loss, in particular, was 25 centavos, or 12½ cents per foot. Some three kilometers of trails were cut along the mountain side to permit moving the drill, and 2,000 cubic meters of rock and earth were removed in cutting trails and drill stations. One of these stations is shown in the illustration on page 821.

On the completion of the work, Mr. B. H. M. Hewett, General Superintendent of Tunnels for Jacobs & Davies, Inc., expressed himself as highly pleased with the results obtained with the Sullivan Diamond Drills.

COMPRESSED AIR AT A WOOD PULP MILL

BY F. D. HOLDSWORTH*

The variety of uses to which compressed air may profitably be put about a manufacturing plant finds unusually good expression at the mills of the Burgess Sulphite Fibre Company at Berlin, N. H. Berlin is on the northern border of the White Mountain region, on the Androscoggin River in northeastern New Hampshire.

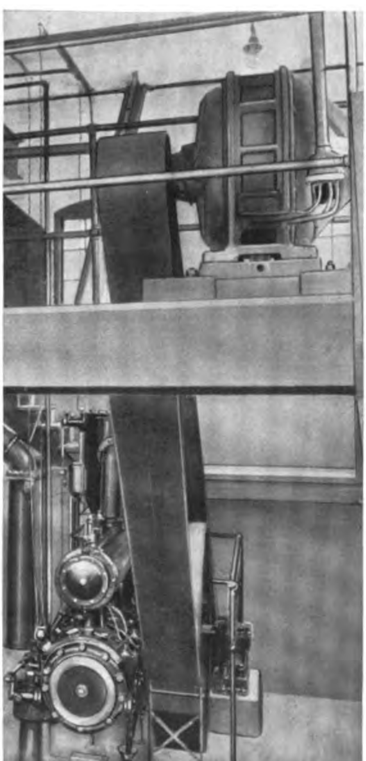
The principal output of this mill is sulphite fibre pulp, and from 600 to 700 cords of wood are used daily in its production.

One important application of com-

*Claremont, New Hampshire.

Mill of the Burgess Sulphite Fibre Company, Berlin, N. H.

pressed air is due to the fact that the entire plant is built on rocky ground, as shown in the photograph on page 823. Every addition or extension to the building, and each alteration, such as changes in the location of the piping, means the removal of rock or the cutting of holes in concrete walls or floors. For this work about 15 compressed air hand hammer drills are employed, including 11 of Sullivan manufacture. Another class of work in which air is employed consists in boring holes in wood and metal. About twenty small pneumatic boring tools are kept on hand for these jobs, and are used also for rolling boiler tubes, etc. In order to prepare the cordwood for treatment it is cut up into small pieces by rotary chipping



Sullivan Angle-Compound Air Compressor, showing overhead motor drive

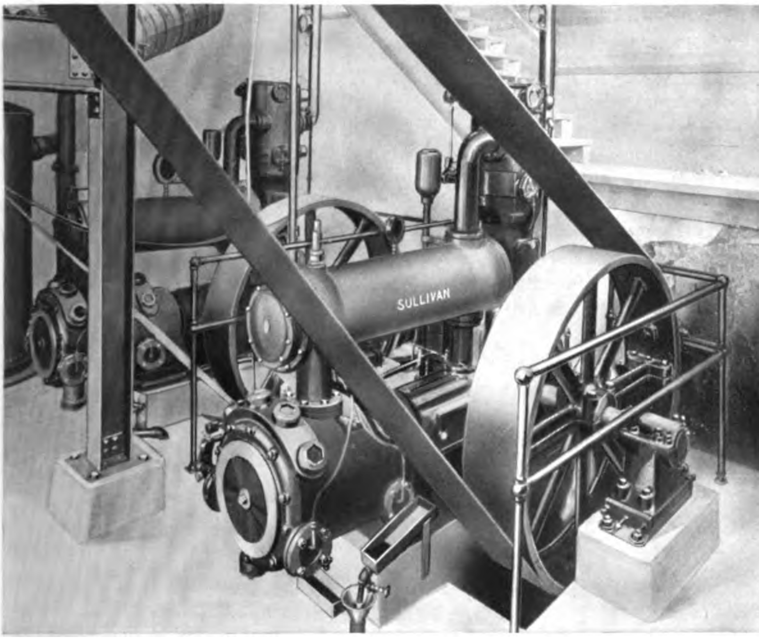
tools. These pieces are then reduced to pulp form by exposing them to the action of sulphur fumes and steam under eighty pounds pressure for a number of hours, in large tanks or digesters.

When the wood has reached the proper state, the valves at the bottom of the digesters are opened, and the pulp is blown into vats. There are eighteen of these digesters, each about 15 feet in diameter and 50 feet high. The shells or coverings are made of very heavy steel plates, so as to withstand the steam pressure of eighty pounds. To protect the plates from the action of the sulphuric acid fumes the entire interior is very carefully lined with a special fire brick, with joints laid with great care in a special acid-resisting cement. When defects are found in this lining, as happens occasionally, they must be repaired immediately so that no acids may penetrate through to the exterior steel plating. Compressed air is used in making these repairs, to cut out the brick with pneumatic chipping hammers.

The gate valves at the bottom of the digesters are 10 inches in diameter. These were formerly opened by hand, a somewhat laborious process, with eighty pounds pressure behind them. They are now arranged to be opened by air, rotary air motors being employed, connected to pulleys mounted on shafts, which in turn are geared to the valve stems. These motors are reversing, so that the valves may be opened or closed at will.

Air whistles are located at a number of points in the plant for signaling purposes, and to call the heads of departments to the telephone.

The finished pulp is conveyed from one point to another about the plant by means of wood stave pipes. This pipe is made of narrow strips of wood arranged in a circle of the desired diameter, and held in shape by hoops of round iron about ¾ inch in diameter, placed at frequent intervals. These hoops are formed at the plant by means of a set of bending rolls. The rolls are operated by a pneumatic rotary drill-



Sullivan ANGLE-COMPOUND Air Compressors of the Burgess Sulphite Fibre Company

ing tool of large size. This is laid on the bench beside the bending rolls and attached to them by a simple coupling. The rotary tool is held from moving by a hook which clamps it to the bench. Hoops can be bent up in a very few minutes to meet all requirements for quite a time, and the rotary drill is then available for other use.

Air hoists are also placed at various points in the mill, for raising the covers from the digester tanks or for similar work.

Another incidental use of air consists in rethreading the numerous odds and ends of bolts that accumulate about a plant of this sort. In a mill of this nature particularly, the threads soon become very rusty, so that the nuts cannot be readily screwed on or off. A rethreading machine, driven by a rotary air tool, has recently been arranged to recut or clean the threads on the bolts, so that the nuts may be easily handled.

AIR COMPRESSORS

Compressed air for the various tools and operations described above is supplied by two Sullivan Angle-Compound compressors, class "WJ-3," with low pressure cylinders 16 inches in diameter, high pressure cylinders 9¾ inches in diameter, and a common stroke of 12 inches.

These machines are shown installed in the illustration above. They are driven by a belt from individual motors, mounted above the compressor, as shown in the small cut on page 824, the angle of drive being about 45 degrees. Each compressor consumes 113 H. P. in supplying 628 cubic feet of free air at 225 revolutions per minute. Ordinarily but one machine is kept busy, the second being held in reserve.

This new type of Sullivan air compressor was described in the January, 1914, issue of Mine and Quarry. It was selected by the Burgess Sulphite Fibre

Company for their plant on account of its large displacement capacity, compared with the small floor area required. This engine room had to be excavated out of the solid rock; consequently, it was important for construction reasons, if for none other, that the air plant should occupy as little room as possible. The overhead drive was another device adopted to economize floor space, and illustrates the adaptability of the ANGLE-COMPOUND Compressor. It will be recalled that the ANGLE-COMPOUND machine has its low pressure cylinder horizontal and the high pressure cylinder vertical, with a horizontal intercooler mounted on the horizontal frame and cylinder. Rotary inlet valves, driven positively, from an eccentric pin on the crank disc, provide efficient means of taking air into the two cylinders of the compressor. Automatic poppet valves, radially arranged on the cylinder heads, discharge the air from the cylinders.

The intercooling area or surface per unit of air capacity is unusually large, and the operating economy and efficiency of these compressors is very high. An unloading device of the total closure pattern on the air intake conduit is provided to save power when air is not needed.

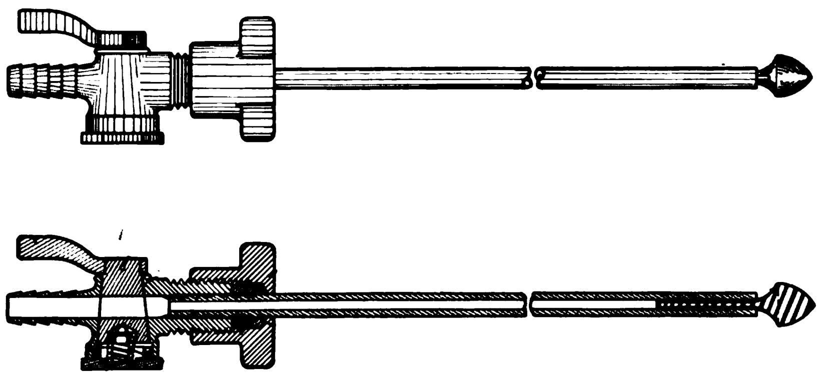
These machines have been installed for nearly a year, and have given very satisfactory service.

PRACTICAL HINTS FOR ROCK-DRILL USERS

FREEING STUCK DRILL STEEL

The use of a water jet under pressure for freeing drill steels that are dust-bound or stuck in the hole is well known to practical drill men. The accompanying sketch shows a special tube that is now carried in stock by the Sullivan Machinery Company for this purpose. The tube is $\frac{3}{8}$-inch inside diameter, and can be supplied in any length up to 10 feet.

As will be noted from the sectional view a hose cock is provided, connected to the tube by a stuffing box, suitably packed, and arranged for connection at the rear end to half-inch water hose. The tapering plug inserted at the front end of the tube can be used or not, as desired. When used, it has the effect of throwing the water out in the form of a spray against the sides of the hole.



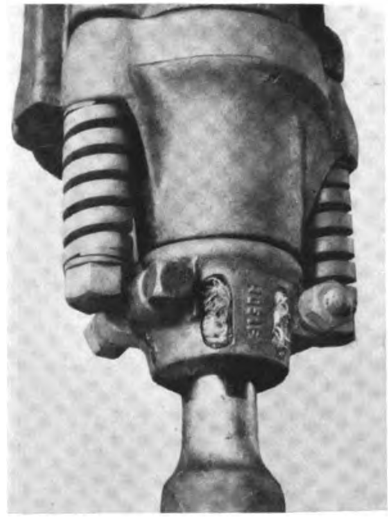
Water Tube for cleaning out drill holes

In practice, in drilling down holes, this device has proved very useful, frequently liberating badly stuck steels in half a minute's time, while steels stuck in the same manner and under the same working conditions required from one to two hours' hard labor before they could be freed without the water jet.

LIFE INSURANCE FOR ROCK DRILL CYLINDERS

One of the main causes of wear in the heads and cylinders and pistons of rock drills is the fact that, in spite of careful packing and close fits in the working parts, some dust and grit is bound to be carried into the head-bushing or lining, and beyond the packing into the drill cylinder. When it arrives at this point, it roughs up or scores the cylinder wall, and even the surface of the piston and the piston ring. This is particularly true in holes drilled above the horizontal, from which the dust and cuttings fall down upon the front head of the machine.

Sullivan drills may now be equipped, either at the factory or in the field, with the device shown in the accompanying cut, known as a "piston rod wiper." As shown, this consists simply of a cage or frame, made in halves to bolt over the front head and around the piston of a rock drill, the purchase on the head being



Piston Rod Wiper

obtained by a groove cast in the halves of the taper lining, or cut in these parts, when the drill is in the field. This cage is kept packed full of waste that has been soaked in oil. As will readily be seen, this waste has the effect of keeping the piston rod, as it reciprocates, constantly wiped clean of any sludge, dust or moisture that may fall upon it during operation. The waste can of course be readily removed, and fresh waste inserted or additional oil put upon it when necessary.

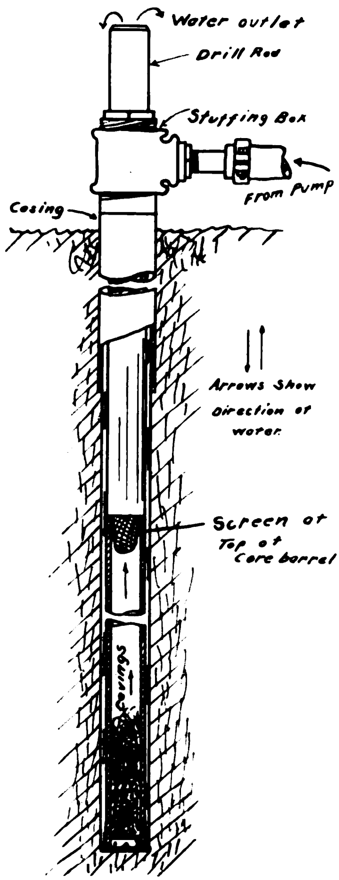
THE DIAMOND DRILLMAN'S LOG — RAPID COAL BORING

In 1912, the Acadia Coal Company, of Stellarton, N. S., tested some of its deposits at a point about 1,500 feet north, or north by east, of the No. 1 Allan shaft. The drilling crew began to set up the drill on July 12th, and on August 17th had completed the hole to a depth of 1,213 feet. The drilling was conducted in two 10-hour shifts per day, 2½ shifts being deducted each week for Sunday. The working time, therefore, amounted to 61½ shifts, or a fraction under 20 feet per shift. This includes the two or three days required to set up the outfit in working order.

The drilling was done for the Acadia Coal Company by the Sullivan Machinery Company on a contract basis. The machine employed was a Sullivan heavy duty, class "N" drill, with a capacity of 2,000 feet, removing a 2-inch core. The *Maritime Mining Record*, of August 28th, 1912, reported that "at 1,085 feet the drill went through 15 feet of fine-looking coal. For the whole distance of the boring until the coal was reached, red shale, soft sandstone or hard fire clay was passed through.

RECOVERING LOST DIAMONDS FROM BORE HOLES

By J. N. Buese*



Recovering a Diamond

Carbon used in the bits for diamond drills are occasionally lost, either by improper setting, running the bits until the carbons have become loose, or sometimes because caved material falls between the drill rods and the wall of the hole, so that when the drill runner begins to pull, difficulty is experienced in getting the bit through this caved material, sometimes to the extent of tearing out a diamond.

On an occasion similar to the last a drill runner on a drill of which I had charge, while pulling through the caved material in a vertical down hole, lost a diamond. In pulling out, the bit caught and dragged very heavily about three feet from bottom; so we conjectured that the lost diamond was at a point about three feet from the bottom of the hole. The drill runner, as is usual, put down a bit filled with soap to take an impression and locate the diamond if possible. He found the hole filled with cavings to about eight feet above bottom and then came outside to notify me.

The drill hole was about 200 feet deep and was cased down about ten or twelve feet. In drilling upper holes we had used a stuffing-box to divert the water as it came from the bit, so that instead of running down along the rods after leaving the collar of the hole, it was conveyed through a hose to one side, thus keeping the men and machine dry.

This stuffing box was simply a 2½-inch tee, one end arranged to have casing screwed into it, the opposite end bushed so that a drill rod passed easily through the bushings; and the middle opening was bushed to take the hose used for drainage.

Below the bushings at the upper end was placed packing, consisting of a strand of unbraided one-inch hemp rope.

I had the runner screw this stuffing box on top of the casing, and then made a screen of No. 8 mesh wire to fit into the top of the core barrel. This screen was coarse enough to allow the water and very fine cuttings and fine cavings to pass through, but small enough so that the diamond could not pass. At the bottom of the core barrel I placed a worn-out bit blank, after cutting the jagged edges off the holes in which the diamonds had been set, and fitting a trap screen about ⅜-inch from the face. This screen was arranged to swing upward, and held from swinging

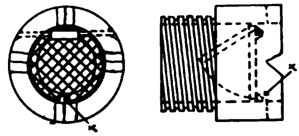
* Mills Building, El Paso, Texas.

below horizontal by a chip of metal from the inside. This chip was made by starting a cut with a small round nose chisel and leaving the chip so that it made a support for the trap. (See sketch.)

The trap was a section of ¾-inch pipe about $\frac{3}{16}$-inch long (for "E" bits); at one edge a small thin sheet-iron loop hinge was soldered; the hole through this hinge was made for $\frac{1}{16}$-inch wire, and across the opposite face of the trap was soldered a piece of No. 8 screen. The solder and edges of the wires were then trimmed off and the trap mounted as shown in the sketch, a piece of $\frac{1}{16}$-inch wire passing through the walls of the bit and hinge holding it.

This bit was then screwed on the core barrel with the wire screen inside and the core barrel and rods lowered into the hole through the stuffing box. When the bit reached the caved material the stuffing box gland was tightened to make it as water tight as possible and the discharge from the pump connected to the hose connection on the middle branch of the stuffing box tee; enough rods were added to the line of rods so that when they should reach bottom there would still be a foot or two above the stuffing box.

When the water was forced down outside the rods it of course went to the bottom and started up through the trap and into the inside of the core barrel, carrying



Trap for Diamond

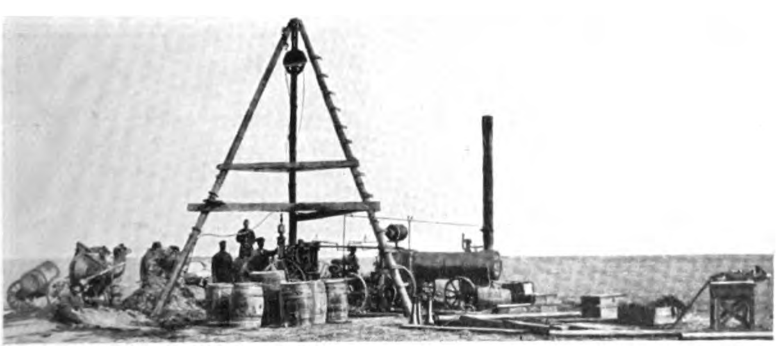
the caved material and the lost diamond with it.

The screen at the top of the core barrel prevented the diamond from being carried up into the rods and the trap at the bottom prevented its escape at the bottom. The rods in the meantime were being turned with wrenches until the bottom of the hole was reached.

After washing to the bottom twice in this manner we pulled and found that we had a core barrel full of cavings.

I made a screen the gauge of which I thought would hold the lost diamond and in this manner screened off the fine material, after which the larger particles were easily picked over and the diamond found.

I have never heard of this method being used, and in a case like the one mentioned no other method except casing would have done, as it was impossible to pick up all the cavings with soap or wax, the usual method, because the hole remained full to about eight feet with cavings. I was cementing the caves, so I did not care to ream the casing down to find the diamond as well as cut off the cave.



Setting up a Sullivan "H" Diamond Drill Owned by Baikanour Copper Mines, Ural Mountain District, Russia

(a) (b) (c)

Fig. A. Limestone blocks before tests; a, block and charge before putting on mud cap for adobe test; b, block drilled and charged for block hole test; c, block and charge after putting on mud cap for adobe test.

(a) (b)

Fig. B. Results of adobe tests; a, with block immersed in water, charge, 100 grams of 40 per cent strength low-freezing dynamite; b, with block in air charge, 50 grams of same explosive.

(a) (b)

Fig. C. Results of block-hole tests; a, with block immersed in water, charge, 5 grams of 40 per cent strength low-freezing dynamite; b, with block in air, charge, 5 grams of same explosive.

ECONOMY OF BLOCK HOLING

Those who have a considerable amount of boulder-breaking to do in construction, mining or quarrying work will be interested in a recent report of the Bureau of Mines entitled, "The Selection of Explosives Used in Engineering and Mining Operations," Bulletin No. 48, by Clarence Hall and Spencer P. Howell.

Part of the report deals with tests made to determine the energy expended by explosives under various conditions. One of these tests was intended to show the restriction on explosive action exercised by water in submarine blasting operations. Incidentally this test showed very conclusively that the block-hole method of breaking boulders and large fragments of rock is very much superior to and more economical than the mud-cap or adobe-shot method of breaking, which is so commonly practiced.

The accompanying illustrations were used in the report, and the following is the portion of it relating to this topic:

"Adobe shots" were made on two high-grade limestone blocks cut from the same large block and weighing 215 and 203 pounds (see a and c, Fig. A). Each block was approximately a cube, measuring 12½ by 12½ by 13 inches. The heavier block was selected for tests in the air. It was laid on two 6 by 6-inch timbers, and on the center of the top side a 50-gram 1¼-inch cartridge of the 40 per cent strength low-freezing dynamite was placed. A No. 6 electric detonator was inserted in the cartridge and laid parallel to the vertical bedding planes of the block. The charge was then covered with a 35-pound mud cap consisting of 30 pounds of dry fire clay mixed with 5 pounds of water (see c, Fig. A) and fired. The block was not shattered on top, but pieces were split off around the sides (see b, Fig. B). The other block was then immersed in a barrel of water having a temperature of 70° F. The water was 32 inches deep, there being 13¼ inches of water above the block. The charge was the same as in the previous trial except that no mud cap was used, and the charge was coated with paraffin in order to protect it from absorbing water. On firing no apparent damage was done to the block and no cracks were visible. This trial was then repeated on the same block immersed in water with a charge of 100 grams (see a, Fig. B). This greater charge did not break up the block as much as did the 50-gram charge when the block was in air only.

Other similar tests confirmed in every particular these tests, and again the confining effect of the surrounding material was shown. The above experimental proof is presented as a confirmation of practical experience that submarine blasting requires larger charges to disrupt a given amount of material than open work on similar materials.

Block-hole tests were made on two similar high-grade limestone blocks cut from the same large block and weighing 198 and 205 pounds. A hole 1 inch in diameter and 6 inches deep was drilled from the center of one side to the center of the block. (See b, Fig. A.) Each was charged with 5 grams of the 40 per cent strength low-freezing dynamite. A No. 6 electric detonator was used. The bore hole was filled with water in each case. The 198-pound block was fired in air (see b, Fig. C) and the 205-pound block was suspended in a barrel of water in the same manner as in the previous tests. Both blocks were broken (see a, Fig. C). The following tabulation shows comparative results: (See page 832.)

It will be noticed from these figures that the quantity of explosive used when a block hole had been drilled into the rock fragment was from one-tenth to one-twentieth as large as that required by the mud-cap or adobe-shot method. This theoretical test has been verified many

COMPARATIVE RESULTS OF ADOBE SHOTS ON LIMESTONE BLOCKS

Condition of Block	Quantity of Explosive used	Weight of Block	Weight of Largest Piece	Number of Pieces over 3 Inches in Diameter	Average Weight of these Pieces	Total Weight of Small Pieces
	Grams	Pounds	Pounds		Pounds	Pounds
In air	50	215	82	13	15.5	11
In water	[a]100	203	104	8	24.6	5

[a] After firing a 50-gram charge.

COMPARATIVE RESULTS OF BLOCK-HOLE TESTS WITH LIMESTONE BLOCKS

	Grams	Pounds	Pounds		Pounds	Pounds
In air	5	198	52	15	12.7	7
In water	5	205	59	11	18.2	5

times in actual practice, as experienced contractors and quarrymen know. The contractors engaged in building a new lock at Sault Ste Marie, Michigan, employed Sullivan Class "DB-19" 40-pound hammer drills for block-holing work some two or three years ago. They found that to break a rock fragment 5x5x4 feet required one hole 28 or 30 inches deep and about one-quarter pound of 20 per cent dynamite with one exploder. For mud capping at least five pounds of dynamite were needed, so that the saving in explosives alone was an important item. Seventy or eighty of these block holes were frequently fired at once on this work.

Block Holing

As to the comparative speed and cost of block-holing with hand hammers and drills and with hand feed hammer drills of the Sullivan "DB-15" and "DB-19" patterns, the following information, reprinted from Mine and Quarry for May, 1911, may be of assistance to those who have much of this work to do.

"A few years ago an air compressor and Sullivan 'D-19' (40 lb.) tools were substituted for hand labor at an eastern quarry. It had previously required 18 hand drillmen to do this work. The manager found that six tools, with one man on each, could do as much work as the 18 hand workmen. The rock at this quarry is very hard granite, not unlike the 'trap' of Bergen Hill, Jersey City, N. J. The holes drilled in the rock fragments averaged 18 inches deep, although some ran to 36 or even 48 inches. Hollow steel was used, sharpened with a cross bit, and the air pressure averaged 80 pounds. The cutting speed ran as high as 2½ inches per minute, but averaged one inch per minute. The saving per day secured by the drills over hand labor may be summarized as follows:

18 hand drillers at $1.50		$27.00
6 hammer drillmen at $1.50	$9.00	
Air compressor operator at	3.50	
One ton of coal	3.00	

Repairs per drill	$ .60	
Oil, etc.	.30	
Interest on plant	.60	$17.00
Saving per day		$10.00
Saving per year of 200 days		$2,000.00

This was about the cost of the plant. The blacksmithing is not included in this estimate, as it was about the same for both the hand and hammer drill steels."

ADVERTISED LETTERS

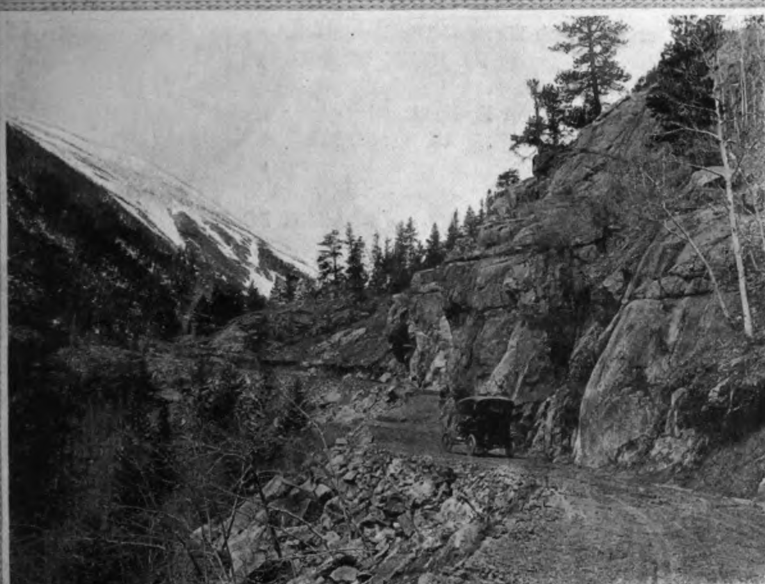
HUNLEY, JOHN W.— Received from John W. Hunley, March 5, 1914, a letter requesting that MINE AND QUARRY be sent to him regularly. As this letter contained no address and was mailed on a railway train, MINE AND QUARRY has not been able to reply to it. If Mr. Hunley should see this notice, he will kindly give us his proper address.

Sullivan Hammer Drill excavating a sewer trench in rock, in the upper part of New York City. The picture shows the great length of steel used, and the relative size of the drill (class "DC-19," weight 42 pounds). The drill was supplied with air by a Sullivan Portable Air Compressor on the street



MINE AND QVARRY

VOL. IX, No. 1 FEBRUARY, 1915 WHOLE No. 29



The Fall River Road, Estes Park to Grand Lake, Colorado

RESCUING A COAL MINE

A UTAH GRANITE ENTERPRISE

A CONNECTICUT RIVER POWER STATION

PVBLISHED BY THE SVLLIVAN MACHINERY CO. 122 S. MICHIGAN AVE. CHICAGO

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MINE AND QVARRY

Vol. IX, No. 1 | FEBRUARY, 1915 | Whole No. 29

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

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Readers are requested to notify MINE AND QUARRY of any correction or change of address.

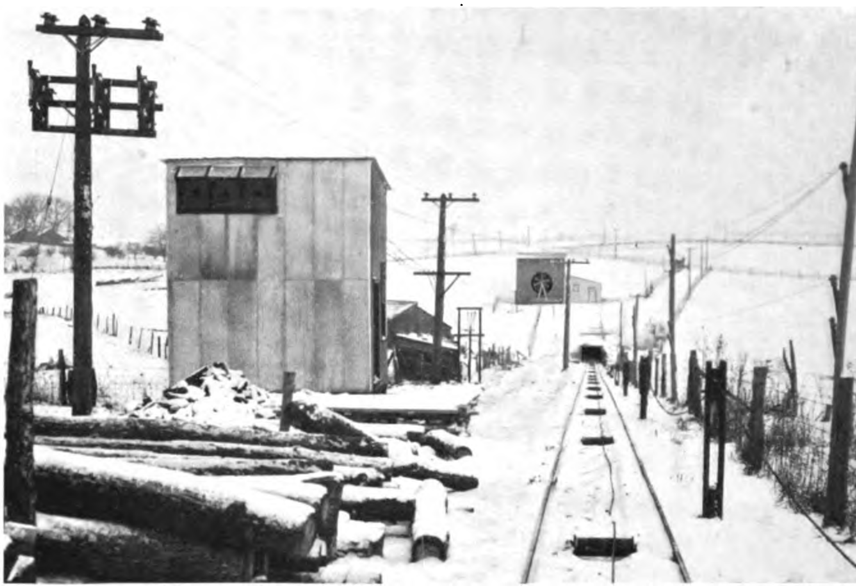
This is the first issue of MINE AND QUARRY since April, 1914. If you receive this number, you have *not* been dropped from the "subscription" list, as the man from Tipperary would put it. Nevertheless, many things have happened since last spring. You may have changed your address, or your business, or be no longer interested in this paper and its objects. So will you please help the editors to keep their list of real live, interested readers as large as possible, and their list of the other kind as small as possible by sending in the card to-day?

Two new hammer drills, placed on the market during the past year, are described briefly in this issue. Within the limits of this article, no detailed accounts of performance have been possible. Specific instances will be related in later numbers, with the necessary detail. The smaller of these two machines is particularly interesting because of the wide variety of uses to which it is being put and its high coefficient of performance as related to weight and strength. It is interesting to recall that the first Sullivan hammer drill with automatic bit rotation was used in the Vermont granite district in 1906. The principle of rotation in the present Rotator is essentially the same as that employed nine years ago. At that time, the rotating drill was in advance of the demand and was laid aside.

A happy, peaceful and prosperous year is the wish of MINE AND QUARRY for its readers, all over the world, at the beginning of 1915. While an early conclusion of the war in Europe is desired on all sides, such a settlement is not now in sight. In the meantime, the United States and the other countries not directly concerned in the struggle, are showing an increasing degree of recuperation from the paralysis of the war's early weeks. This is a period of readjustment, of establishing new relations, of opening new avenues for trade. While the volume of mining and industrial enterprise of 1912 and 1913 cannot be looked for in 1915, the tone of business, already firm and confident, promises consistent gains as the year advances.

In the meantime, managers and engineers are having a brief breathing space from the strain of top-notch production. In this interim, they are more than ever interested in posting themselves on improved methods and machinery for saving labor and cost and increasing production. It is the hope of the editors that MINE AND QUARRY may be of increasing use to its readers in this direction.

Mr. James E. O'Rourke, for many years connected with the Sullivan Machinery Company, and recently in charge of its office at Joplin, Mo., has resigned to accept the position of assistant to the president of the American Zinc, Lead and Smelting Company, of Joplin, Platteville, Wis., and Mascot, Tenn. Mr. O'Rourke will be in charge of underground mining methods at the company's mines. Mr. R. D. Willets, formerly attached to the United Iron Works, the Sullivan agency at Seattle, will fill Mr. O'Rourke's old position at Joplin.



Slope, Transformer station and fan, Bolton-Hoover Mine. The electric wires enter the mine through a borehole, where the " A " frame shows

A room in the Bolton-Hoover Mine, after being undercut with a Sullivan Ironclad

RESCUING AN IOWA MINE WITH IRONCLAD COAL CUTTERS

By Jonathan A. Noyes*

Since the inauguration, in April of last year, of the new agreement between the Iowa coal operators and the miners of District No. 13 of the U. M. W. of A., a number of the Iowa mines have installed electric mining machines. The reason for this new and general interest in mining by machines is that this is the first time an agreement between the miners and operators has provided satisfactory working scales for machine mining under normal conditions. Previous to this time, however, several deficient mines in the state were mining all their coal with machines. The 1914 to 1916 Des Moines agreement provides working scales for machine mining under all conditions with an attractive differential in favor of machines.

The lump coal (over 1⅜-in. screen) mining rate in sub-district No. 2, in which the mine described below is located, is $1.05 per ton for hand mining. For loading after electric mining machines, miners are paid 70 cents per ton for screened lump coal, or 49 cents per ton run of mine. This rate includes loading, shooting, and furnishing explosives. Machine crews are paid by the day, $3.25 going to the runner and $3.00 to the helper.

It is the purpose of this article to point out some of the advantages other than the differential scale to be gained by machine mining in Iowa. To be specific, it will describe the property of the Bolton-Hoover Coal Company at Oskaloosa, where Sullivan Ironclad continuous cutting electric machines have been installed since the establishment of the new agreement.

THE BOLTON-HOOVER MINE

The Bolton-Hoover mine is in sub-district No. 2 on the Burlington-Des Moines branch of the C. B. & Q. R. R., five miles west of Oskaloosa. The entrance to the mine is by a slope, as shown in the accompanying cut, page 834.

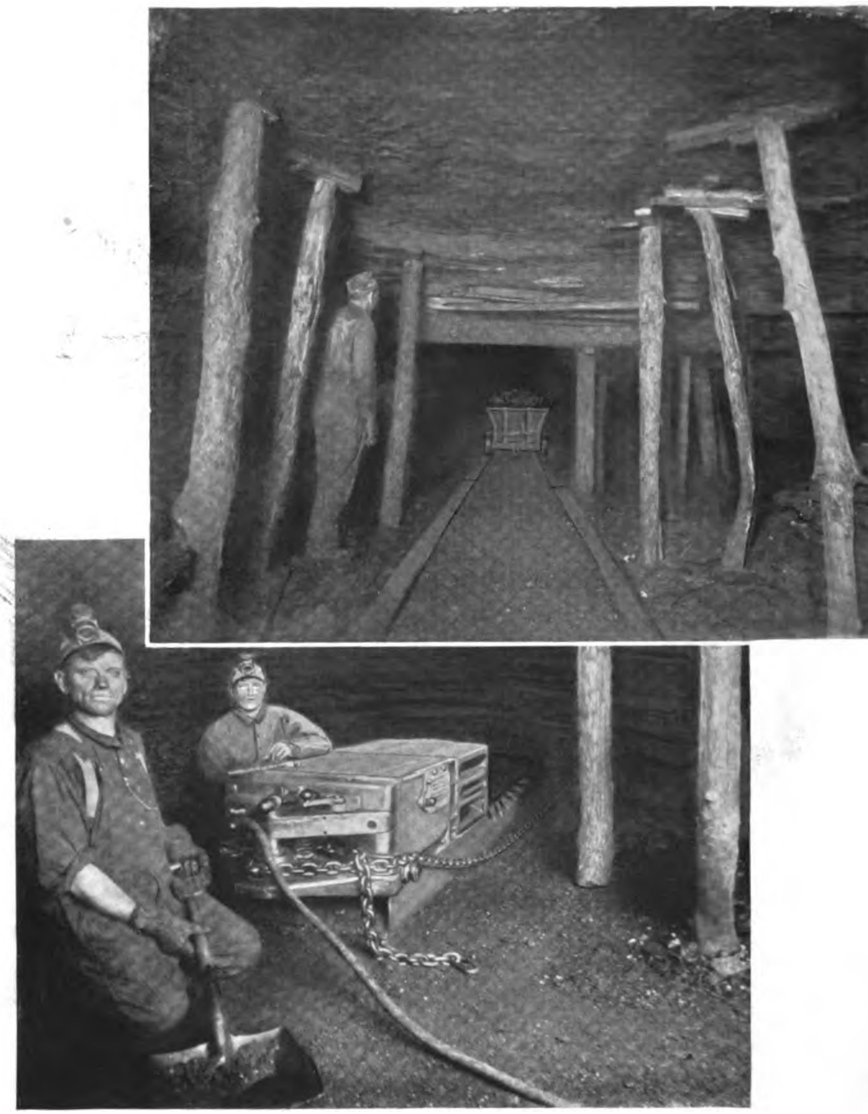
This view also shows the fan, beyond the entrance to the slope, and in the foreground is the transformer house. The company buys power for the operation of its machines from the Des Moines Electric Company, and to secure service it was necessary to build a high tension power line for a distance of about six miles. The power is transmitted at 13,000 volts alternating current. At the transformer house at the mine the voltage is stepped down to 220 volts and the alternating current power is carried underground through a bore hole, located between the transformer house and the entrance to the slope, as shown in the picture. Number 4–0 wire is used from the transformer house for about 1,000 feet and 2–0 wire branches off from this to the different machines. A set of extra leads on the secondary side of the transformers will permit taking off power at 270 volts. Therefore, as the distance increases the voltage can be raised, so as to overcome the additional line loss, and thus always maintain normal voltage at the machines.

MINE-WRECKING BY SHOOTING OFF THE SOLID

The vein averages six feet in thickness and the seam is quite clean except close to the bottom, where there are frequent impurities, consisting of sulphur bands and some rocks projecting from the bottom. The coal is somewhat laminated horizontally and is inclined to be soft, both of which features are hindrances to shooting off the solid successfully.

The cover over this vein averages only 20 to 50 feet, including drift, and the roof conditions are very poor. Directly over the coal is a treacherous false top, varying from 18 inches to four feet in thickness,

*3707 Grand Avenue, Des Moines, Iowa.



Above, nine-foot head room in foreground, result of solid shooting; five-foot props in rear, where machine undercutting was begun. Below, Sullivan A. C. Ironclad sumping with props six feet from the face

and consisting of a rotted gray slate containing coal pipes. Above this false top is eight or ten feet of slate, carrying the drift.

The mine is worked on the double entry room and pillar system, the rooms being about 25 feet wide and ultimately 200 feet deep, and the pillars are 12 feet thick. The entries are carried eight feet wide and five feet high above the rails. In shooting off

the solid it was impossible to hold the weak top, as the heavy shots not only cut the roof but knocked out the timbers. In many places three and four feet of top would come down the full width of the room. This not only made it very dangerous for the miner; but as yardage had to be paid for on all the roof taken down, the cost of this dead work, together with the heavy cost of timbers, nine or ten feet long, made it practically prohibitive for the company to keep the places open; and the whole south side of the mine had been abandoned for this reason. Many of the rooms had to be turned two and three times before they had been driven 150 feet.

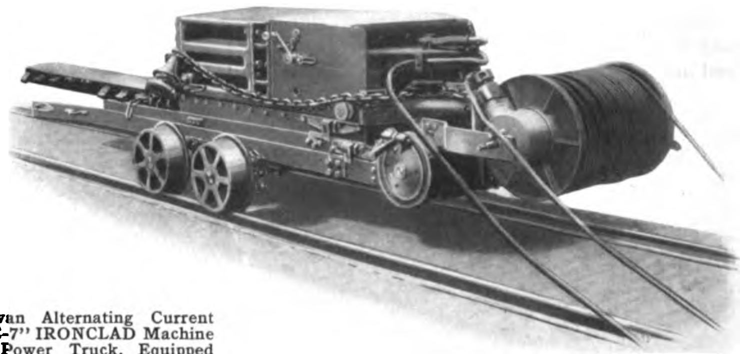
MINING MACHINES

The machines recently installed here, after a thorough competitive test, are of the Sullivan Ironclad continuous cutting alternating current type. Each is equipped with a 30 H.P. induction motor wound for 220-volt, 3-phase, 60-cycle current. The machine is moved from place to place about the mine on its own power truck, as shown in the cut, page 838. The Ironclad also loads itself onto this power truck and unloads itself under its own power. After the machine is unloaded in a room it makes a sump cut at the right rib until the cutter bar, which is 6½ feet long, is entirely under the coal. The machine then feeds itself across the full width of the face at a single cut without withdrawing the cutter bar from under the coal until the left rib is reached. The machine travels along the feed chain, which is stretched across the face and held at each rib with a single pipe jack, at the rate of 18 inches per minute. This feed mechanism is driven through a friction release, so that the speed of travel across the face is automatically reduced when exceptionally hard cutting is encountered, as in sulphur bands. As the cutter chain travels at constant speed at all times this automatic reduction in the rate of feed permits cutting under severe conditions. Under these conditions a positive feed would be entirely impractical. The frictional release also affords an absolute protection to the machine against overloads.

LESS POWDER NEEDED AFTER UNDERCUTTING

In shooting down the coal after it has been mined by the machines, less than one-eighth as much powder is required as when shooting off the solid. In the former case, 75 to 80 tons are broken by one keg of powder, as against 8 to 12 tons per keg after solid shooting. By leaving about 12 inches of top coal, which can be done with this light shooting, the roof troubles are entirely obviated. The accompanying picture, page 836, shows a room where the effect of machine mining is clearly demonstrated. In the left foreground is a man standing erect, and the timbers where he stands are all nine feet long. In the background this same picture shows the 12 inches of top coal left for protection. The timbers there are only 4½ and five feet long. Another picture, page 834, shows a view taken closer to the face in the same room. The timbers nearest the face are 12 to 14 feet from it, as shown by the tape. This room had just been undercut, which practically adds six feet more to the length of unsupported roof.

The Ironclad machine makes its mining in the coal except where sulphur bands are encountered. There the machine is made to cut beneath these or other foreign matter in the vein. Very little of the coal is snubbed by hand, the general practice being to put in two snubbing shots to split the seam. A hole is drilled about two feet from each rib and about 2½ feet from the bottom, to a depth of about 4½ feet. By shooting these rib holes first the vein is in effect split horizontally from rib to rib. Top holes are then placed about three feet from each rib and drilled to within about 12 inches of the back of the mining. This method of shooting not only eliminates hand snubb-



Sullivan Alternating Current "CE-7" IRONCLAD Machine on Power Truck, Equipped with Friction Drive and Brake

ing, but it rolls out the coal in large lumps, reducing the amount of slack to less than half what it was when shooting off the solid.

Each two loaders are assigned two places, one place being cut while the other is loaded out. The track is in the center of the room, so that the coal needs to be rolled only a short distance, and the two loaders can work conveniently in one place. Of course, the work of the machine crew, consisting of a runner and his helper, is entirely separate from that of the loaders.

With a six-foot undercut one face foot gives one ton of mine-run coal and a 25-foot place averages 20 tons of lump, or 80 per cent. The two loaders will load this out in about two days, so each place in the mine need be cut only every four days. In this cutting the machine averages about 125 feet of face, or, in other words, about five places per day, so that one machine will handle nicely about 20 places in four days. This is, of course, an average performance and under favorable conditions is considerably bettered.

By leaving the 12 inches of coal to protect the roof, the rooms can be kept open indefinitely and every bit of the pillar coal can be robbed back easily with the machine.

At the Bolton-Hoover mine the successful application of the Sullivan Ironclad Mining Machines has been fully demonstrated. The advantages accruing from their use, aside from the scale differential, may be summed up as follows: (1) the elimination of roof troubles, (2) increased safety to the mine and miners, (3) ease with which new territory can be opened, (4) large increase in the amount of lump coal and proportionate increase in the value of the total product; (5) besides all these is the great advantage of being able profitably to get coal for probably eight to ten years from a mine which must have been abandoned in less than two years if shooting off the solid had been continued.

At present the mine is shipping about 350 tons per day. This coal is of a good commercial steam grade, and is sold in Omaha, Sioux City, Lincoln, Neb., etc.

The writer is indebted to Mr. J. W. Canty, General Mine Superintendent of the Bolton-Hoover properties, for the data and pictures contained in this article. Mr. Canty was formerly mine inspector for the State of Iowa and has had a long experience with coal mining in Iowa and also in Colorado, where he was division superintendent for the properties of the Rocky Mountain Fuel Company, and where he was able to adapt machines to very difficult conditions and achieve unusually successful results by their use. Mr. W. W. Branigar is General Manager and Secretary of the company.

LOW DRILL REPAIR COST ON THE GOGEBIC RANGE

By J. F. Berteling*

Unusually low costs for drill repairs are reported in work done during the first half of 1914 at the Mikado Mine, Verona, Michigan, on the Gogebic Iron Range. The drills employed embodied novel features of design, intended to increase the wearing power of the machines and to render them easier to handle under severe conditions. That these objects were secured in a very large measure appears from the account given below.

In the first week of January, 1914, the Verona Mining Company began to sink the last 175 feet of its Mikado shaft at Verona, Michigan. For this work four Sullivan LITEWEIGHT, Class "FL-12," 3¼-inch cylinder drills were purchased. The actual work of sinking was done with two machines, the other two being kept at hand to be used in case of breakdowns or delays. The dimensions of the shaft were 8x16 feet outside the timbers; a round consisted of from 28 to 32 holes, and the material was an exceedingly hard quartzite. Air was supplied the drills at 85 pounds receiver pressure.

When the work was begun, the holes were drilled to a depth of six feet, but as sinking progressed it was found that better results were obtained with deeper holes, owing to the tightness of the ground. The holes were therefore increased to a depth of eight feet; and when squaring up the bottom, when one side was too high, the holes were occasionally drilled to 9½ feet, with no apparent reduction in drilling speed.

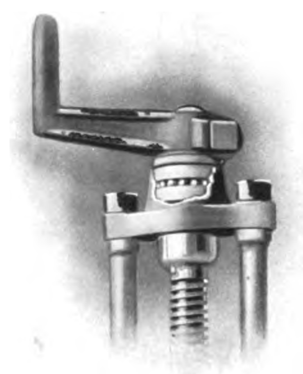
After completing the shaft, 175 feet in depth, a pump station was cut in the quartzite, 15x30x10 feet in size, and a crosscut, 257 feet long and 8x8 feet in size, was also driven in the same material. All this work was done by the same two machines that had been used in the shaft. This work consumed 6½ months, during 5½ months of which time three working shifts were employed. The repair bill on these two drills for the above period, from January 1st to July 15th, amounted to $24.09, giving a cost per machine of $1.69 per month, or of $0.015 per cubic yard of rock excavated, the total amount being 1605 cubic yards.

So far as can be learned, this is a low record for repair cost, especially for big machines, in hard rock on the Gogebic Range. A feature, in addition to the low repair bill above mentioned, that was particularly pleasing to the management, was the fact that no delays were caused by breakage of the machines, as all replacements were made while the muck was being cleaned away at the end of the drilling round.

The Sullivan LITEWEIGHT "FL-12" drill, employed on this work, represents the latest development in reciprocating piston machines for mine use. The cylinders, instead of being hardened and ground in the bore, are fitted with a separate steel liner whose walls are hardened throughout, and which is forced into the cylinder bore under a hydraulic pressure of many tons. At the end of the working period mentioned above these cylinders were carefully measured, and the superintendent reported that no wear could be detected in them.

The valve motion is of the familiar Sullivan air-thrown differential pattern, but the valve chest contains some new features. The valve buffers, instead of being screwed into the chest, are held in place by side rods with flat leaf steel springs at each end of the chest. The valve itself runs in interchangeable hardened steel bushings, which can be replaced in a few moments if wear occurs. The valve is further equipped with end seats to reduce leakage. The rifle bar is of the five flute pattern with a solid steel ring

*Ishpeming, Michigan.

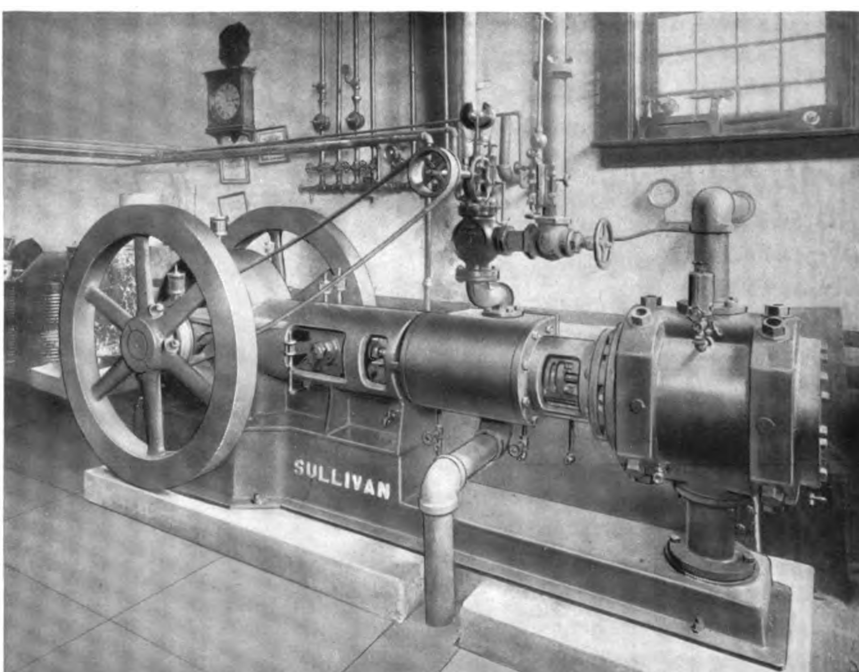


Ball Bearing Crank Handle

and a tail rod or rear bearing to prevent side play. The front cylinder head is drop forged and provided with a removable taper lining. At the back head is provided an equalizer to insure equal strain being placed on both side rods. The front head of the piston is reduced in area to prevent the danger of upsetting and scoring the cylinder walls.

A feature in these machines that met particular favor with the runners consisted in a set of ball bearings, immediately under the crank handle. The superintendent stated that on the 9½-foot holes this ball bearing crank was of particular value. It was almost as easy for the runner to crank back the long steels as a two-foot starter. One of the miners was curious to know what made his machine crank back so easily, and was only enlightened when he had succeeded in losing a number of the balls out of the race.

In addition to the Mikado mine, the Castile, Eureka, Cary, Ottawa, and Montreal are members of the Gogebic Range group in which these Sullivan "FL-12" 3¼-inch LITEWEIGHT drills are in use.



Sullivan " WA-4 " Air Compressor, Fort Pitt Brewing Company, Sharpsburg, Pa.

AIR LIFT PUMPING WITH ELEVATED DISCHARGE

By John Oliphant*

The following article describes the pneumatic pumping equipment of the Fort Pitt Brewing Company, at Sharpsburg, Pa. This installation has several points of interest for those considering pumping by the air lift. These are:

1. A river as a source of supply, with adjacent gravel beds as a natural filter.
2. Improved type of pneumatic pump.
3. Long, horizontal delivery from well tops, with final elevation, by "boosters," employing air already used for lifting the water from the wells.

The Fort Pitt Brewing Co. had for some time been laboring under the disadvantage of an inadequate and unsatisfactory water supply. Previous to the installation of the pneumatic pumping plant, described below, they had been using Allegheny River water, supplied by the municipality of Sharpsburg. The cost and high temperature of this supply made that part of their operation extremely expensive.

They were contemplating the material enlargement of their bottling department, and the question of a sufficient supply of pure and cold water became of first importance. Mr. J. Richard Kommer, president of the Federal Engineering Company, of Pittsburgh, recommended the drilling and testing of a well in the gravel strata adjacent to the Allegheny River, but so arranged that the river water would be filtered through a gravel bed, and thus purified.

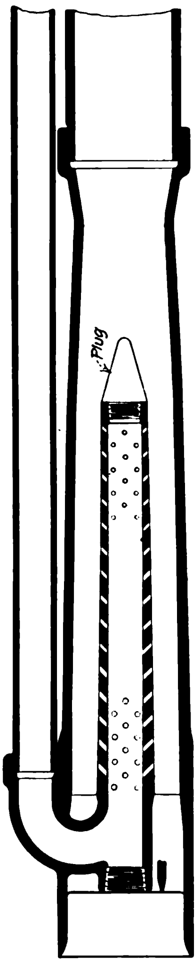
A test well was drilled upon the bank of the river, 1,350 feet distant from the plant. This well was 10 inches in diameter and 110 feet deep, with a 10-inch perforated strainer, 12 feet long, situated in the gravel bed at a depth of 60 feet. Upon testing with compressed air, this well was found to produce 200 gallons of cold and pure water per minute. Mr. Kommer then located two other wells of the same size and depth, as shown in the cut on page 843, having a common discharge line to the receiving basin at the brewery. The head, or height of lift to the basin, including friction is about 25 feet above the top of the well.

*122 So. Michigan Ave., Chicago.

A Sullivan steam driven, straight-line, class "WA-4" air compressor, having a steam cylinder 12 inches in diameter by 12-inch stroke, and an air cylinder 14 inches in diameter by 12-inch stroke, was installed in the engine room, with a vertical steel air receiver 36 inches in diameter by eight feet high, just outside. This machine supplies air at a terminal pressure of 34 pounds per square inch, the piston displacement being 248 cubic feet, at 116 R.P.M. The air inlet passage to the compressor was carried outside of the engine room and properly screened, to prevent the admission of dirt, etc. A common air line was laid underground, with branches to each well. Foot pieces were installed in the wells, at a depth of 105 feet, using a 3-inch pipe discharge to carry the water to the surface. The submergence is 58 per cent, and the pumping head in the well 30 feet.

The foot pieces used are of the Sullivan type, in which a thorough mixture of the air and water is aimed at. This is found to give less slippage of air and consequently higher efficiency than the original Pohlé plan of alternating "plugs" of air and water. The air is carried down outside the well casing in a one-inch pipe, which at the bottom enters the elbow of the foot-piece within the pipe. This foot-piece is about 12 inches high, $1\frac{1}{16}$ inches inside diameter, and is pierced with rows of holes $\frac{3}{8}$ inch in diameter, having an upward inclination of 45 degrees. There are four holes in each circle.

This arrangement insures a very thorough mixture of the air with the body



Sectional view of foot-piece of the Sullivan Air-lift Pump

of water. Above the mixing tube the discharge is reduced to 2½ inches by means of a ventura or choke in order to increase the velocity.

The booster at the head of each well is shown on page 843. It consists of a cast-iron chamber 30 x 30 inches, with bottom connections to the well-delivery pipe and the discharge main. The delivery pipe extends up into the chamber and the stream of air and water discharged from it strikes a mushroom plate, which aids in the separation of air from the water. The end of the discharge main also extends up into the chamber and has its end slotted, while a drop pipe or sleeve over this end compels the water to pass upward before entering the pipe. A baffle-plate checks the splashing, and maintains comparatively still water around the discharge.

There is an open exhaust for the released air to escape to the atmosphere, but this is throttled by a valve so as to retain sufficient pressure above the water in the chamber to force it through the discharge pipe to the required distance. With the exhaust pipe full open it will discharge air and water, but the valve is closed until only air escapes. The operating pressure, as stated above, is 34 lbs. at the receiver of the compressor, and the back pressure in the booster chamber is about 11 lbs.

Each well has its own booster, and four-inch discharge main, these three mains connecting with an eight-inch main to the cistern at the plant, where it discharges under water.

The boosters are set in pits below the ground level, and enclosed in brick or concrete dry-wells. The engineer operates the complete plant from the compressor, no adjustment being required other than varying speed of the compressor to secure a greater or less amount of water.

The air, which is slightly recompressed by the discharge momentum of the water into the booster, drives the water as a solid mass before it through the long discharge line, nearly one-quarter of a mile to the brewery and up into the receiving basin. The cut below shows the water from the eight-inch discharge line discharging below the surface in the reservoir, which has a capacity of 18,500 gallons. The pump shown on top of the reservoir is an Epping-Carpenter duplex steam pump, used for forcing the water into a tank in the tower of the building and through the brewery system.

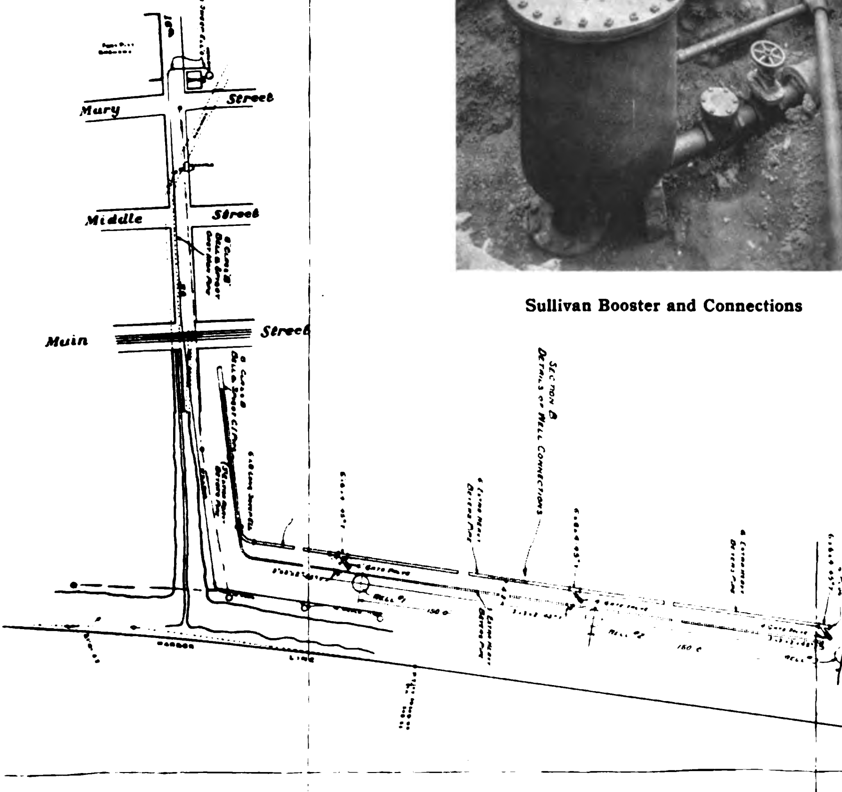
RESULTS AND EFFICIENCY

With the system in full operation, from all three wells, the reservoir is completely

Reservoir at end of discharge line

filled in 25 minutes, or at the rate of 740 gallons per minute. The guaranteed delivery was but 450 gallons per minute. Prior to the installation of this system, the temperature of the water supply at the same season of the year (late spring) was 70 to 80 degrees Fahrenheit. The water from the new system was delivered at 52 degrees. As a large portion of the supply is used for condensing, this reduction in temperature alone constitutes an important economy. The water itself is clear and sparkling and fit for drinking purposes without boiling or distilling, as the result of the filtering action caused by its passage through the gravel deposits along the river, where the wells are situated. The water is also more soluble (due to aeration) as well as purer and clearer than the river water, making it

Sullivan Booster and Connections



Arrangement of wells and flow lines for Fort Pitt Brewing Co.

much more satisfactory for boiler feeding purposes.

The efficiency of the system, viz., the relation of indicated horsepower in the compressor's steam cylinder to the work done, figures out at 40 per cent, an excellent result in this class of pumping.

The plant was designed by the Federal Engineering Co., of Pittsburgh, of which Mr. J. R. Kommer is president. As stated above, the air compressor, booster, and air lift equipment were installed by the Sullivan Machinery Company, the details being worked out by the writer.

A NEW CONNECTICUT RIVER HYDRO-ELECTRIC STATION

CONTRIBUTED

The No. 2 station of the Turner's Falls Company, at Montague City, Mass., will be, when completed, the largest hydro-electric plant on the Connecticut River. Forty-seven thousand horsepower will be developed by this plant, under an average head of 56 feet.

Turner's Falls was one of the earliest power sites developed on the Connecticut, the considerable drop in the river there being utilized to provide power for the operation of some of the first paper mills to be established in New England. This industry is still the principal one of the community. In recent years, Turner's Falls has become an important power producing center, and is advertised as "the home of the white coal." The Turner's Falls Company was incorporated in 1792 and reorganized in 1867. It is chiefly responsible for the industrial growth of the locality. The Turner's Falls Company itself merely generates power, which it sells to distributing companies such as the Greenfield Electric Light Company, the Franklin Electric Light Company, and the Amherst Power Company. Through the latter corporation, electricity is disposed of to the Mt. Tom Power Co., of Holyoke, the United Electric Light Co., at Springfield, and to other consumers within a radius of 50 to 60 miles.

The No. 1 power plant is at Turner's

Coffer-Dam and excavation in May, 1914. Montague City, Mass.

Falls, and derives power from a new concrete dam that has been under construction in sections since 1912. The previous dam, a timber crib structure 1,000 feet long, had stood since 1867. The brick and concrete headgate building at the east end of the dam is the largest in New England. This portion of the work was constructed by the Bates and Rogers Construction Co., of Chicago, and the new dam and power house will have an ultimate capacity of 7,000 h.p.

Sullivan Autotraction Drill Rig and Sullivan Hollow Piston Drill

CANAL AND FOREBAY

In order to develop the maximum water power available, it was decided to construct a canal from Turner's Falls to Montague City, two miles lower down the river. In this distance, the river falls about 17 feet. At Montague City, the No. 2 power station is being constructed. The canal is 1⅞ miles long, 150 feet wide, and 18 feet deep. It will have a width of 300 feet and a depth of 25 feet at the intake of the power house. A large forebay, about three-quarters of a mile long and one-third of a mile in width, of an oval shape, will provide an equalizing effect on the flow of water. All logs, river ice, etc., will, of course, be diverted from the entrance to the canal above the dam.

The contract for the canal and forebay was let to the Holbrook, Cabot & Rollins Co., of New York. It involves the removal of 800,000 cubic yards of earth, mainly sand, and of 150,000 cubic yards of rock. The contract price of this work is $500,000. A considerable amount of concrete retaining wall must also be constructed. Work on this part of the enterprise, viz., the canal and forebay, is well under way, steam shovels and scrapers being employed. It will not be completed until some time next season.

NO. 2 POWER STATION

The contract for the foundation section of the new power house and of the gate house was let to Fred. T. Ley and Company, Inc., of Springfield, Mass.

The power house will be 235 feet long by 125 feet wide, and will set parallel to the course of the river, the gate house and intake being on the land side. The available head is 56 feet. Six turbo-generators of 8,000 h.p. rating will ultimately be installed, providing a nominal capacity, at the average estimated water stage in the river, of 47,000 h.p.

Only three of the units are to be installed at first, although all six draft tubes have been installed. The power will be generated at 55,000 volts, to be transmitted to the purchasers' lines.

Sullivan Hollow Piston Tripod Drill putting in lifters; note character of rock

F. T. Ley and Company began work on their contract about the middle of March last, and the gate house, draft tubes, and foundation for the power house were completed prior to December 1st. This contract, for which the Ley Company received $300,000, involved the excavation of 50,000 cubic yards of rock, 30,000 cubic yards of earth, and the placing of about 25,000 cubic yards of concrete.

EXCAVATION

The location of the work was on the river bank, which is about 50 feet high at this point. A drag line excavator was first put to work removing the soil and sand over-burden. A coffer-dam was built out into the river to lay bare the bed, and permitted excavation in the dry to a point 16 feet below water level. The down-stream portion of this coffer-dam consisted of two rows of interlocking sheet steel piling, 40 feet long, driven 20 feet deep by steam hammers. The rows were about 15 feet apart, and the space between was filled in with sand and gravel. Above this piling, and before it was driven, a wing dam was constructed of heavy timber cribbing, floated out from the bank and sunk by loading with rock. Three-inch plank were then driven outside the crib to make it water tight.

HOLLOW PISTON ROCK DRILL

When the earth on the river bank had been removed, the rock on the level portion was drilled to a depth of 30 feet and shot for removal by a steam shovel. This work was done with a Sullivan class "FV-14" submarine type rock drill with hollow piston and hollow drill steel, mounted on an autotraction carriage to facilitate moving from hole to hole. The drill and the carriage engines were operated by compressed air from the central power house.

With this machine, three-inch holes 30 feet deep were drilled 10 feet apart, averaging from 150 to 210 feet per 10-hour day. The best day's work accomplished was eight 30-foot holes, the outfit being moved seven times.

A churn drill or blast hole driller on the adjoining contract averaged only 60 to 75 feet of hole per day.

The formation here consisted of partially disintegrated sandstone, increasing in solidity and hardness with depth until some rock of considerable hardness was encountered in the last few feet of the holes. The rock lay on a pitch of 20 to 30 degrees away from the river, in thin strata. In this formation, the cleaning action secured by the blast of exhaust air, discharged to the face of the bit through the hollow piston and drill steel, was particularly valuable. It prevented the clogging of the bit by accumulated chips and dust, and secured a clean rock face for the bit to strike at all times.

When the holes were drilled, they were sprung with dynamite and then shot, the resulting debris being in most cases small enough to be handled by a 35-ton Marion steam shovel with a one and one-half yard dipper.

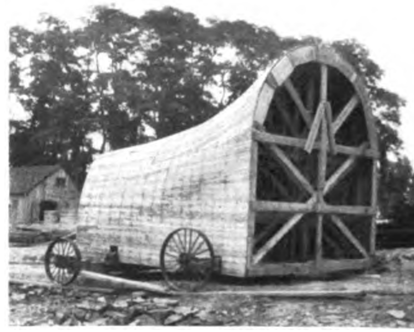
Below the edge of the bank all rock drilling was performed with tripod machines of the 3¼-inch piston type. Four to six of these drills were used, including one Sullivan Hyspeed "air jet" drill, with hollow piston and equipped with hollow steel. The rock encountered here was the broken sandstone mentioned above, resting on much harder courses of limestone, tilted at 30 to 45 degrees, and breaking very irregularly. The depth of the drill holes varied accordingly from three or four up to 16 or 18 feet. The air jet drill showed the same facility in keeping the holes free in this soft broken rock as the autotraction drill above mentioned. It averaged 80 feet of hole per day of ten hours, as against 50 to 60 feet for the drills with solid steel and solid pistons. Water was occasionally poured in around the steel, to make a sludge of the cuttings. The steel used was 1½-inch round hollow, sharpened with a cross bit. The hole in the steel to discharge air to clean away the cuttings was brought out at the base of the bit, between two of the wings, thus securing a better cleaning effect and less liability of clogging than would have been the case if the hole had been drilled through the center of the bit face.

The excavation was on three levels, namely, that of the forebay, gate house, and draft tubes. On the lowest level as much solid rock as possible was left between the draft tubes.

All the holes were bottomed for one-inch powder, and 50 per cent dynamite, made at Kingston, N. Y., was chiefly used. The large rock fragments were piled at convenient points for subsequent use in the foundation. These were placed between and around the draft tubes to give added strength and solidity. The sand and lime rock found was unsuitable for concrete work, so that all the broken material except the solid fragments just described was sent over the dump, down stream. Fragments too large to be

Montague City Excavation and plant in July, 1914

Getting River Gravel for Concrete



A draft tube form

handled by the derricks or steam shovel were blockholed with Sullivan hand feed hammer drills, just before blasting time, so that these holes might be loaded and shot with the others. The drills used for this purpose included one "DP-33" Rotator and several "DC-19" hand rotation tools.

WASTE MATERIAL

The spoil was handled by one large stiff leg spar derrick and two guy derricks, these having masts about 90 feet and booms 75 feet long. These were operated by hoisting engines, having cylinders about 7x10 inches in size, run by steam from boilers close by. Two engines were piped to permit substitution of air for steam if necessary. The material broken by blasting was loaded into skips or handled by chains, in the case of large pieces. The derricks delivered this spoil to six-yard Western dump cars, hauled by dinkey locomotives of the saddle-tank pattern, and running on standard gauge track.

Compressed air for the drills, one or two hoists, and the concrete mixers, was furnished by a Sullivan Angle Compound air compressor, class "WJ-3," with air cylinders 18 and 11 inches in diameter, by 14-inch stroke. At 200 r.p.m. it had a rated capacity of 886 cubic feet piston displacement. The compressor was driven by belt from a 150 h.p. motor, set behind the machine to save space; and furnished air at 100 pounds' pressure. A total-closure, double beat unloading valve on the low pressure cylinder inlet was employed to save power when the full capacity of the machine was not required.

CONCRETE WORK

The concrete was of two grades: (1) Grade "A," a 1–2–4 mixture, using crushed blue trap rock from a quarry a short distance away. The crusher run is 1½-inch size. (2) Grade "B" consisted of one part of cement, three of sand, and five of gravel. All sand was secured from a near-by bank, in an excellent grade equivalent to white beach sand. The gravel was excavated from the river bed by a clam shell dredge bucket operated from a stiff leg derrick with structural steel boom. This derrick was mounted on a scow anchored outside the cofferdam. All cement used was of the "Ironclad" brand, made at Glenn's Falls, N. Y. Grade "A" concrete has been used for all water courses, in the penstocks, gate house, and draft tubes, where a strong mixture and smooth, close, water tight wall was needed. Grade "B" was employed in other walls, floors, etc. The concrete materials were handled in a scientific and economical manner. The cement storehouse was on the top of the

bank, and near by separate bins were provided for sand, crushed stone, and gravel. The latter was raised from the river level in mine skips, running on an inclined railway about 50 feet high to the top of the bin, by a separate, steam-driven, 7x12-inch Flory hoist. The skip was loaded from a square wooden hopper having a spout at the bottom, and kept filled by the clam shell dredge. The bins were of heavy lumber, strengthened by numerous tie rods. The cement was discharged to the mixers by iron tubes about eight inches in diameter. Two mixers were used, a double cone T. L. Smith motor-driven machine for the grade "B" or gravel mixture, and a Municipal Engineering Co.'s cube mixer for the grade "A" concrete, operated by compressed air.

The Innsley chute system was employed for placing the concrete. A wooden tower about 115 feet high was constructed at about the center of the work, on the bank, and the concrete was run up inside this, in a skip or bucket, discharged at the top into a hopper, and distributed through a jointed chute or pipe to any desired point on the work.

ORGANIZATION AND EQUIPMENT

The contractor assembled a very complete equipment and organization for this enterprise. There were a separate storehouse, blacksmith shop, air compressor house, machine shop, carpenter shop, office and drafting room. All forms for the concrete work, with the exception of those for the draft tubes, were constructed on the work. About 175 men were employed under the personal direction of Mr. A. A. Morris, superintendent.

Sullivan Hollow Piston Drill. The air jet blows out the cuttings, keeping the hole clean

The writer acknowledges, with thanks, information furnished by Mr. Morris and his assistants, Mr. Abbott, master mechanic, and Mr. Tobin, drill foreman.

The pictures of the autotraction drill were taken in May, the others in early July. The site for the power house was selected by the consulting engineer, Mr. Safford, of Lowell, Mass., after thoroughly proving up the rock formation by means of Sullivan diamond core drills.

Mr. Turner is chief engineer for the Turner's Falls Company. The power equipment is being selected by the mechanical engineer, Mr. Moody.

Mr. Joseph Meyerowitch, manager of the Petrograd agency of the Sullivan Machinery Company, was at Kissingen, Germany with his wife, on a vacation, when the war broke out. He was detained by the German authorities for several weeks, but was finally allowed to return to Russia. Several members of the Sullivan staff at Paris are on the firing line. Mr. J. J. Scalabrino is with the French army, and Mr. Rey was called to the Swiss colors at the beginning of hostilities. Messrs. Hoy and Belding of the company's London office, have been serving on the American relief committee.

Sullivan Post Puncher putting in a top cut, La Fayette, Colorado

TOP CUTTING IN COAL MINES

By G. W. Blackinton*

While undercutting is by all odds the most economical method of mining coal, when the conditions permit—and they do so permit in probably 95 per cent of American mines—the presence of partings in the coal, of sulphur bands or bad roof may make it desirable to put in the mining at the top of the seam or at some midway point instead of at the bottom. The picture on this page shows a Sullivan post puncher putting in a top cut in the Vulcan Mine of the Rocky Mountain Fuel Co., La Fayette, Colorado.

At the Vulcan Mine a peculiar condition of roof exists. The formation is lignite, and the seam seven to eight feet thick. The roof is comparatively soft and experience showed that when the coal was cut in the ordinary manner it was difficult to keep the roof standing. The accepted method of mining is, therefore, to leave about 18 inches of coal to act as roof. The post puncher and the top cutting method replaced undercutting with an ordinary pick machine. After undercutting when the coal was shot with even a light charge of powder, the roof suffered from the effects of the shot and eventually broke off along the rib.

The post puncher, which can be used for either shearing or mining, by means of a worm and segment, is mounted on a column, as near as possible to the roof, so as to leave an offset for the next cut. This offset can be seen easily in the photograph, which also shows where the post puncher has made its previous cut, just back of the set-up. The mining is put in to a depth of about seven feet, the full width of the room. Light shots are placed about 18 inches above the floor and these of course have no effect whatever on the roof.

The runner cuts two 20-foot rooms in an eight-hour shift, setting the column or post twice in each room. With this method of mining the results have been

*University Club, Denver, Colorado.

very successful, although the progress made is naturally not as rapid, in the actual mining of coal, as with the regular type of puncher machine.

The mining machines at this property are supplied with air by a Sullivan class "WB-2" straightline steam driven air compressor, size 20x22x14x24 inches, with two stage air cylinders, having a capacity of 1,100 cubic feet of free air per minute.

A Sullivan post puncher, set up for operation, will be shown this year in the model mine room of the Pacific Coast Coal Company's exhibit, in the Mining Building, at the Panama-Pacific International Exposition at San Francisco. The model room described above will be full size, that is, large enough so that visitors will be able to go inside and see for themselves the actual conditions in this company's mine at Coal Creek, Washington. The coal seam at this point pitches 38 degrees, and the Sullivan post punchers are used to mine the coal up the pitch. The seam is about 4½ feet high.

TWO NEW SULLIVAN DRILLS

STAFF ARTICLE

During the past year two new types of Sullivan hammer drills have been placed on the market and are giving excellent service. One of these is a hand-feed tool, but capable of being used on a mounting also; while the second is a mounted machine of greater power, intended as a substitute for the piston drill, under conditions favoring hammer drill action.

A detailed description is impossible in the space available, but the photographs and the brief remarks that follow will give an idea of the range of use of these new drills.

SULLIVAN ROTATOR

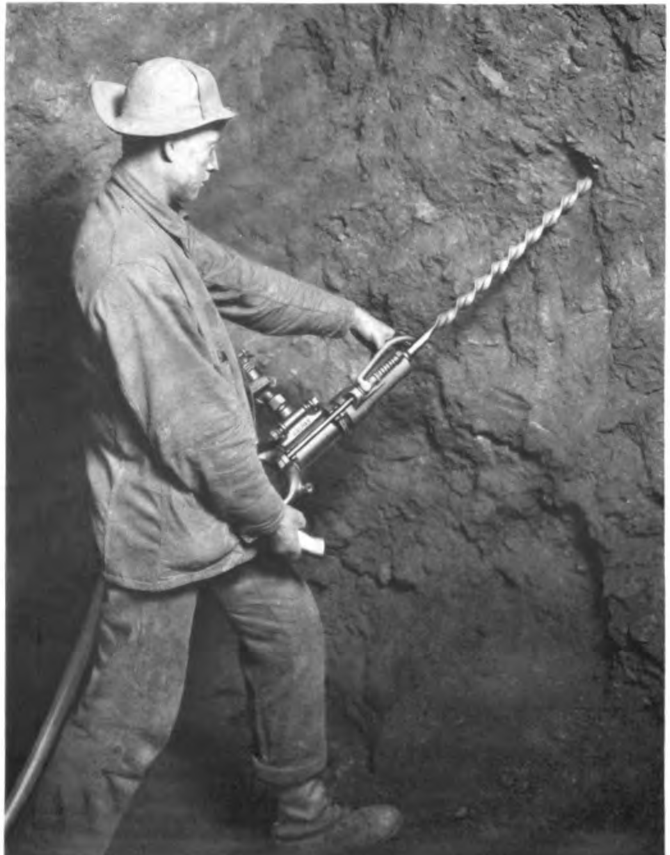
The Sullivan Rotator, class "DP-33," is, as implied by the name, a self-rotating drill, and is intended primarily for use as a hand tool, for blockholing, shaft sinking, cutting trenches, and other drilling that may be done conveniently without a mounting. It is a substantial tool and a very powerful one, made throughout of steel, worked up from drop forgings and bar stock. Although weighing only 38 pounds, it is capable of drilling holes 12 feet deep under most conditions, and has actually drilled to a depth of 30 feet, as illustrated by the picture on page 854.

The Rotator has a 2¼-inch cylinder, requires ¾-inch hose for air or steam, and employs ⅞-inch hollow hexagonal steel, usually with a rose bit. Below is given a list of the features characteristic of the Rotator.

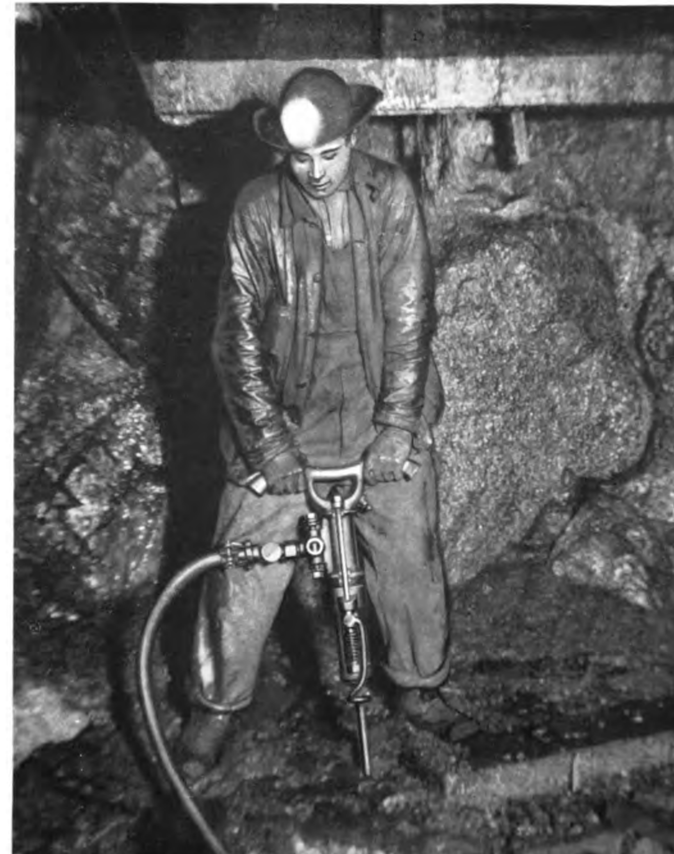
1. Automatic rotation of drill steel.

2. Retainer to hold the drill steel in place automatically.

Sullivan "Rotator" Hammer Drill



Sullivan "DP-33" "Rotator" stoping in soft iron ore, Ishpeming, Michigan, with solid twisted steel and fish-tail bit. Operator releasing steel-holder to change bits



Sullivan "DP-33" "Rotator" sinking a shaft in iron ore formation at Bessemer, Michigan

3. Automatic lubrication.

4. Positive rotation, and absence of separate rifle bar.

5. Sullivan differential valve motion.

6. Valve chest an integral part of cylinder forging, with removable valve bushings.

7. Minimum vibration, power consumption and number of parts.

8. Maximum durability.

9. Removable chuck bushing.

10. Dust tight front head housing.

11. Air jet or air and water jet, to clean the hole.

12. Uses air or steam.

In explanation of items 1 and 4, it may be said that the front portion of the piston is milled with spiral and straight flutes, which so engage the ratcheting device as to permit a free forward stroke or blow, while imparting a rotary motion to the bit on the return stroke. This method of rotation, in addition to dispensing with a separate rifle bar, confines the rotating parts to the front end of the tool, so that the work of turning the steel is performed in the most direct manner.

The drill contains a lubricator, supplied from a chamber in the handle, which admits oil to the cylinder with each pulsation of the air under pressure, thus providing proper lubrication of the working parts while the tool is running.

AIR AND WATER JETS

The piston and back head are bored out to receive a small tube, which is arranged to carry a charge of live air or steam to the hollow drill steel, and through this to the bottom of the hole, to throw out the cuttings or sludge. This feature, by permitting the bit to deliver an unimpeded blow upon the rock at all times, is a great aid to drilling speed. In drilling horizontal or upper holes, a water attachment may be provided, thus giving a combined jet of air and water. The same device has been used with much success in Sullivan hollow piston and water jet reciprocating piston drills.

DRILL STEEL

In addition to the standard hollow hexagonal drill steel, various kinds of solid and hollow steel may be used, to suit the ground being drilled. These include solid twisted spiral steel, with a fish tail or "V" bit (for use in soft ore or coal), solid, spiral steel, sharpened with a "Z" bit, and hollow spiral steel, also with a "Z" bit.

FEED SCREW MOUNTING

For light drifting work, the Rotator, mounted on a skeleton shell and feed screw has shown great advantages, due to its lightness and high speed, especially when equipped with the water attachment.

The drill rests in a cradle which forms part of the shell, and is secured by two hinged strap connections, one over the handle and one over the chuck housing, as shown on page 856.

The Rotator probably approaches more nearly to being an "all-around" rock drilling tool than any other model thus far developed. In spite of its small size and weight, it is being used efficiently for all classes of down-hole drilling except the heaviest. With its mounting it competes with mounted reciprocating piston machines in drifting, raising, or even light tunneling, and on a stope bar can be used in default of an air-feed stoper. It has the advantage over the regular stoper and mounted piston drill of being quickly dismounted for use in block-holing, trimming, drilling a bench, or cutting a ditch or sump.

It is at all times a "one-man drill," as its column, shell, etc., can be handled separately with ease by one man.

By varying the steel and by using the water attachment, the Rotator is adaptable to a wide variety of drilling conditions and rock formations.

"DR6" MOUNTED HAMMER DRILL, WITH WATER ATTACHMENT

No trade name, similar to "Rotator," has as yet been adopted for the larger of the


Rotator with water attachment drilling a hole 30 feet deep in a schist formation

The "DR6" has a 2½-inch cylinder, and is intended for the range of drilling usually comprised in drifting or tunneling. Its distinctive features may be outlined as follows:

1. Water and air are used for cleaning the hole of its cuttings.

2. A single throttle valve controls both water and air. In its first position the throttle admits air only to the drill steel, to blow out any dust or mud that may have settled in the hole. In its second position, both water and air are admitted, and in its third, or wide open position, the throttle admits air and water to the steel, and air to the valve and piston to operate the drill. In closing the throttle, the operation is just reversed. The fact that a jet of air only is blown through the steel just before closing the throttle, results in cleaning the steel itself and the drill hole of cuttings and water. This prevents water from running back into the drill cylinder.

This throttle also relieves the operator of the necessity of opening and closing the hose valve in the water line, when changing drill steel.

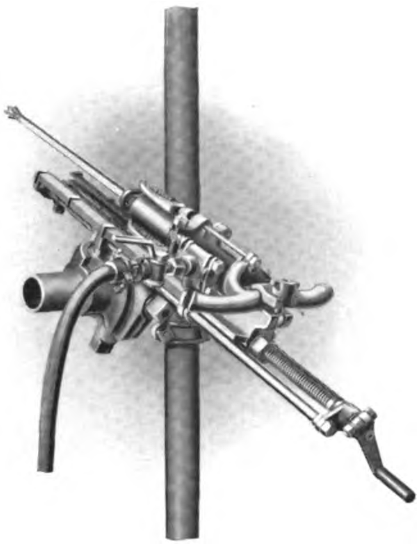
3. Lock Ring chuck. The drill steel has two projecting wings or lugs, about four inches from the rear end. To secure the steel in the chuck, it is merely necessary to insert it, and turn a locking ring by hand. To remove the steel, the locking ring only is turned, and not the steel. This is a convenience when the steel happens to become stuck fast, as in that

two drills described in this article. In Joplin, it is known as the "Doctor" drill, a title rendered apt by the symbol letters and by the fact that its water jet prevents the sharp rock dust from being scattered about the working place and thus removes the cause of miner's phthisis.

The "DR6" is a mounted hammer drill, weighing 145 pounds and capable of drilling 1¼-inch holes to a depth of 12 feet.

It employs hollow round steel, through which a jet of air and water is forced to clean the hole, the cuttings being expelled in a thin sludge. The drill, water tank, hose and connections are illustrated on page 855.

Sullivan " DR-6 " Mounted Hammer Drill with water attachment, showing water tank, water and air hose lines and connections



Rotator on cradle mounting, on a column arm. This cut shows the standard or "dry" drill; the Rotator with water tube may be used equally well on this mounting

event the drill may be cranked back off the shank, and delay avoided.

4. Valve motion. As will be noted from the pictures, this drill has no projecting valve chest. The hollow shell valve is placed in the rear head, so that the valve and piston motion are in alignment. End seats prevent leakage and result in sustained efficiency. The absence of a chest on top of the cylinder permits the operator to change steel without shifting the drill on its mounting.

5. Automatic rotation. No separate rifle bar is employed, the piston being grooved at the front end to engage a retaining bushing in the chuck and a ratchet of the same type as that of the "Rotator." The rotation is thus confined to the front end of the tool. The piston is a solid piece, as in the case of the "Rotator."

6. Automatic lubrication. Lubrication of the drill while actually running is provided by an automatic, differential pressure oiler, situated in the back head, and similar to that used in the "Rotator."

7. Dust tight chuck. The construction of the chuck and chuck housing is such as to form a tight joint, so as to prevent dust or cuttings from entering the rotating parts or the cylinder.

8. An equalizer is provided for the back head, so that an even strain is thrown on both side rods, keeping all parts in exact alignment and preventing breakage of side rods, as well as undue wear on the cylinder and chuck bushing.

9. All parts, except the feed screw and its accompanying mechanism, are made up from hardened steel, ground to exact size and interchangeable. The "DR6" is distinctly a machine shop product. Some of its parts are worked up from solid drop forged billets of special formula steel, while others are machined from the solid bar. Special heat processes have been developed to give the proper hardness and toughness to the various parts.

As a result of the careful design and construction evidenced above, the "DR6" possesses unusual advantages in high drilling speed, low air consumption, durability and convenience. The positive prevention of rock dust in confined working places is a valuable advantage possessed by this drill in common with other water jet machines.

The water attachment for the "DR6" drill and for the "DP33" Rotator is practically the same as that used with Sullivan water jet piston drills. When it is not possible to connect to a pipe line, a steel tank is provided, with hose to connect to the drill, and a hose line from the air main to the tank to furnish pressure. A needle valve in the water supply hose enables the runner to regulate the amount of water used very closely.

The new Petrograd address of the International Engineering & Trading Company, Sullivan agents for Russia and Siberia, is Bolshaia Koniushennaia 29.

The new Utah State Capitol, Salt Lake City (From Architect's drawing

A UTAH GRANITE ENTERPRISE

By J. H. Henning*

The new capitol building for the State of Utah, now in course of construction at Salt Lake City, bids fair to be the most magnificent and imposing public building in the intermountain region. This fact is the more noteworthy as it is being constructed chiefly from Utah materials. Home industry was given the preference in practically every instance, but the contract for the granite to be used in the exterior walls and columns was awarded to a local firm only after a long discussion. There was no doubting the fact that the Utah granite had the required quality and could be furnished in unlimited quantities; but whether the capital necessary for the development of the quarries could be secured, and the question of opening them up in time to be of use on the impending contract were matters of considerable speculation.

As no single stone company in the state felt quite able to handle the contract alone, the leading stone contractors of Utah joined hands and formed the Utah Consolidated Stone Company, thus insuring the necessary financial backing. The contract, calling for 165,000 cubic feet of stone at a price of $609,000, was finally awarded to this concern.

The first things to be considered after securing the contract were transportation, and finishing plants of adequate size. The Little Cottonwood Quarries, from which the stone was to be taken, were ten miles from the nearest railroad connection. The right of way of an old railroad to the mouth of Little Cottonwood Canyon, abandoned many years ago when the Alta mining district ceased to be an important shipper, proved available for this new enterprise, and the road was soon placed in operation.

Meanwhile machinery had been installed at the quarry and the two finishing plants, one located in Midvale and the other in Salt Lake City.

THE QUARRY

The quarry is located on the north side of Little Cottonwood Canyon near the Wasatch Hotel. It is at about the same place as that from which the stone was

*Kearns Bldg., Salt Lake City.

General views of the mountain of granite known as the Little Cottonwood Quarry

Nearer views of the quarries, showing tremendous blocks

Sullivan " DC-19 " bottoming a 12-ft. hole. Sullivan plug drills at work

taken by the Mormons for the erection of the magnificent Salt Lake City Temple. In that case, however, the stone was quarried by hand, and by crude methods, and its delivery covered a period of nearly 40 years; while the stone for the Capitol had to be delivered inside of two years' time Unlike most of the quarries in Vermont and other eastern districts, where it is necessary to follow the stone into the

ground, the granite here is on the surface and ready to be loaded on the cars as rapidly as it can be broken into blocks of the proper size. An almost inexhaustible supply of this granite is at hand, the face of the mountain being of an excellent grade for building purposes. Blocks up to 75 feet long and of any width and thickness required may be quarried, the size being limited only by the capacity of the derricks. Practically all of the stone previously taken from the quarry came from small blocks and boulders loosened by the elements, the main supply never having been touched.

Water power from a canyon stream is used for driving the compressors, which furnish the air for the operation of the drills, and the two derricks, each of which has a capacity of twenty tons.

The stone is loosened and broken into blocks of workable size by the use of hammer drills, no piston machines being required. The deep holes for blocking out the stone are drilled with the Sullivan "DC-19" 440-pound machine. This drill works satisfactorily in the granite to a depth of 12 feet. The blocks are broken into pieces of proper dimensions for the finishing operations by Sullivan "DA-15" plug drills. The stone is then loaded on the cars for transportation to the cutting sheds.

The average daily output of the quarry is two cars of stone or between 75 and 100 tons. About 40 men are employed, under the direction of James S. Walker.

FINISHING SHOPS

Three finishing plants are operated by the company, two of which are given over entirely to work on the capitol contract.

The largest of the finishing plants is located at Midvale, ten miles south of Salt Lake, where the branch railroad from the quarry joins the main line of the Denver & Rio Grande system. It is one of the largest stone dressing plants in the west. The shed is 480 feet long by 43 feet in width. The heavier pieces of stone are finished here; and a large amount of machinery was installed, including compressors, drills, surfacers lathes, gang saws, travelling cranes, forges, machine tools, etc., for properly handling the work. The gang saws, of which there are two, are the largest in the intermountain country and can readily saw a block of stone 8x9x10 feet. There is a large turning lathe, capable of swinging a shaft of granite 32 feet long and eight feet in diameter, and weighing 62 tons. Eight compressed air surfacers are used for dressing the faces of the blocks. Their daily capacity is from 50 to 60 square feet each.

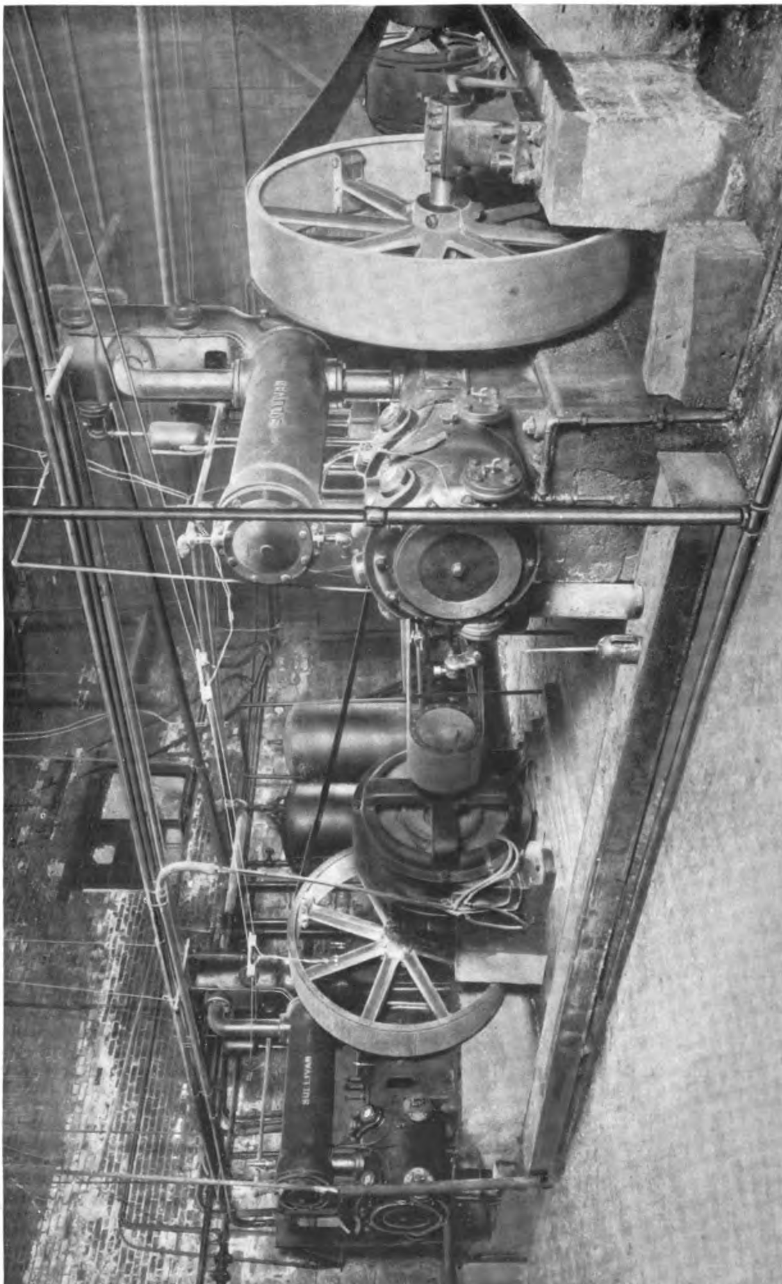
Electric power is used for driving the compressors (see page 860) and a generator for the travelling crane service.

About 30 tons of finished stone are handled daily, and employment is furnished to over 100 men. Mr. George Curley is superintendent at Midvale.

The Ashton-Whyte plant of the company is located in Salt Lake City and has practically the same equipment as at Midvale, with the exception of the lathes. About half of the work for the capitol building is turned out at this point. The finished stone is loaded on street railway cars for its final journey to the capitol grounds; that from the Midvale plant being transferred at this point. Mr. James B. Whyte is in charge of the plant and has about 100 men under his supervision.

The Walker finishing sheds are also located in Salt Lake City and, though soft stone is chiefly handled, some work is also being done on granite for the capitol. Superintendent S. H. Belmont employs a force of 25 men at the plant.

The contract for supplying the stone was let on September 18th, 1913, and notwithstanding the many difficulties to be overcome in such a large proposition, regular deliveries were begun in less than 60 days from that time. At present the company has completed over 90 per cent of its contract, being at all times safely



Two Sullivan "WJ3," Angle Compound Air Compressors, in the Midvale plant of the Utah Consolidated Stone Company

ahead of deliveries on its material. As a result, a new Utah industry has been started on a sufficiently large scale to enable it to compete with any granite concern in the west, both in the quality of its product and promptness of delivery.

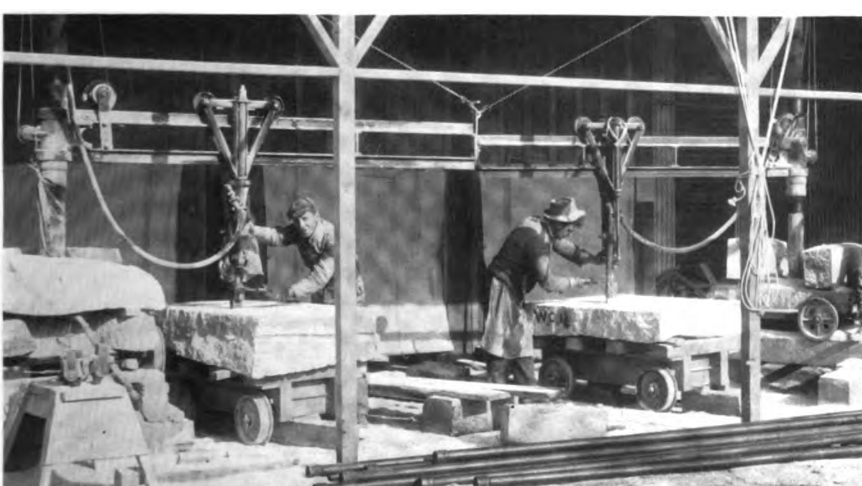
Six Sullivan air compressors are being used on this work. Four of these are of the latest Angle-Compound belt driven type, of the 628-foot size, one being at the quarry, two at the Midvale Plant and one at the Ashton-Whyte yards. The other two are small single-stage machines.

The Angle-Compound compressors, notwithstanding the fact that they are required to deliver their maximum output almost without interruption during the day, have given continuous service. One of the single-stage machines (a 10x12 WG-3), located at the Ashton-Whyte yards, and for which a speed of 160 R.P.M. is recommended by the builders, has been run for several months at 200 R.P.M. without an unloading device, so that it is, at all times, delivering its maximum capacity; but no bad effects have been noted due to working with this big overload.

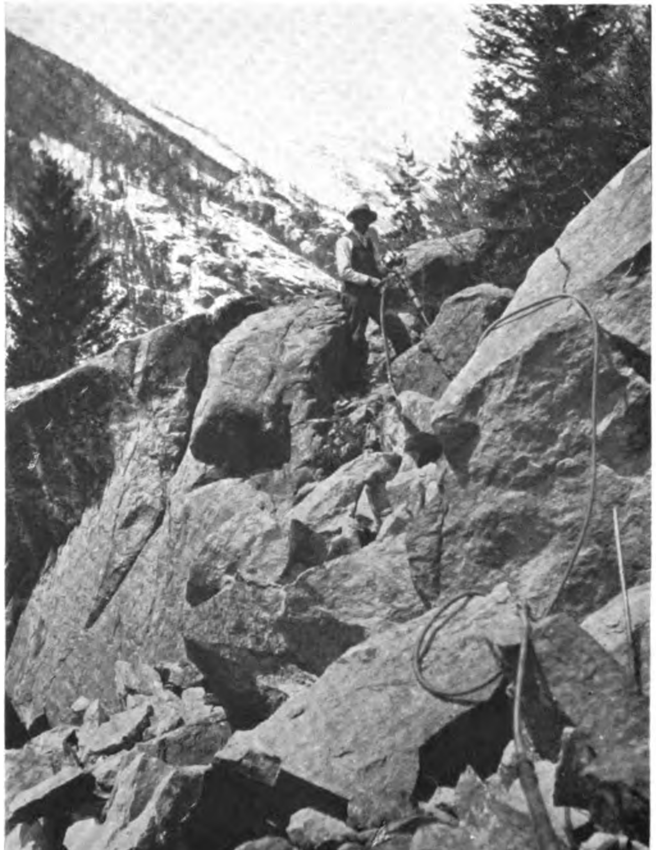
After trying out all prominent makes of tools for use on their work, the company, in every possible instance, has standardized on those of Sullivan manufacture. There are about 50 in all, consisting of plug drills, (DA-15), deep hole drills (DC-19), and surfacers (D-28). If nothing unforeseen occurs, the contract will be completed some little time before April 15, 1915, the date set for delivery on the last of the stone.

The writer wishes to thank Superintendent James B. Whyte and Mr. James S. Walker, Jr., for courtesies extended in the work of gathering information and pictures for this article; and also the "Salt Lake Mining Review," whose issue of June 30, 1914 contains an article on the same subject.

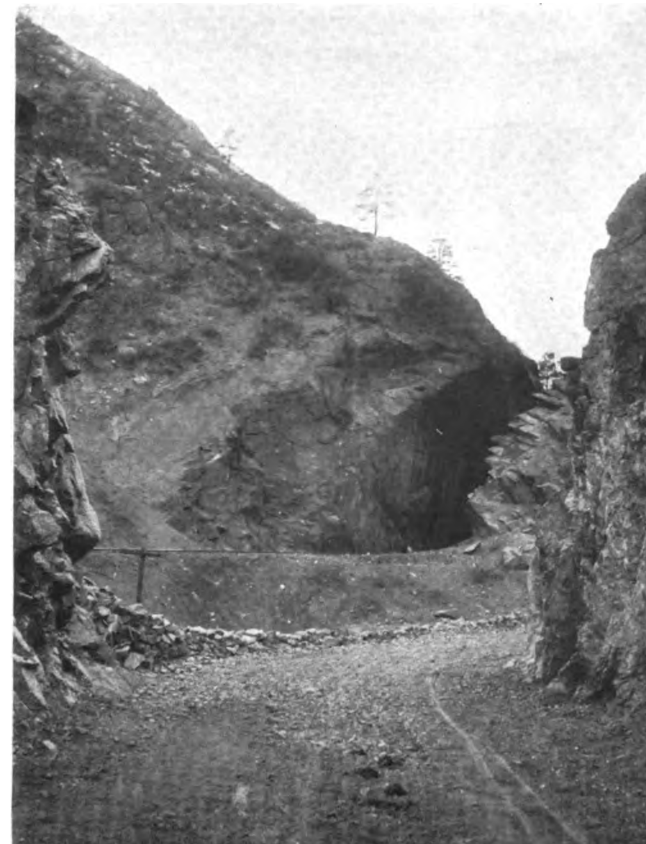
The Compania Ingeniera, Importadora, Y Contratista, 2A Capuchinas 49, Mexico City, has been appointed sales agent for Sullivan Air Compressors, Diamond Core Drills, Rock Drills and Hammer Drills in Southern Mexico. Mr. F. R. Alger, for several years a sales engineer at the Chicago office of the Sullivan Machinery Company, is in personal charge of the company's interests.



Sullivan Surfacing Tools in Ashton-Whyte Yards of the Utah Consolidated Stone Co., Salt Lake City



Sullivan Hammer Drill in operation on the Fall River Road in Colorado



View on the Royal Gorge Road in Colorado,—showing heavy rock cut

ROAD BUILDING IN THE ROCKIES

By Earl E. Miller*

Colorado is one of the most active of the western states, in the movement for good roads. The new state highway commission is conducting an aggressive campaign, in which the road commissioners of many counties are energetically co-operating. Routes for proposed new highways are made to form, so far as possible, links in a chain of roads reaching across the state. The revenue for these roads is derived in part from the sale of public lands, which amounted, in 1913, to nearly $600,000; and in part from the counties directly concerned.

The actual construction is in all cases in direct charge of the Boards of County Commissioners, who may select their own method of performing the work, and are responsible to the State Highway Commission only for the results effected.

Three widely different plans for road construction have been used by the commissioners of the various counties; namely (1) The placing of the entire work in charge of a superintendent, who is directly responsible to the commissioners; (2) The letting of the road by contract; (3) The system which has now generally supplanted the two former, viz: the use of convict labor.

It is easy to understand why this plan has sprung into general use, when one considers the difficulties attending road building in Colorado, due to the physical situation of the State.

The more densely populated portions of the United States, the eastern and western slopes, are separated by the almost insuperable wall of the Rocky Mountains. The very few available passes are approached by deep and narrow gorges, where the walls of the cañons rise from the water's edge, and where permanent road building requires, not only engineering ability, but also improved methods and modern equipment. Superintendent Thomas Lancaster, in charge of work on the Fall River Road says:

"The use of convicts in building roads in Colorado has been a success beyond all anticipation. The men are selected for the work by State Warden Tynan on their prison record. They receive ten days per month off their time, and at the time of their discharge a complete suit of clothing and ten dollars. They are quartered in tents in summer and cabins in winter and have plenty of good wholesome food. There are no armed guards in the camp. Two men, a superintendent and an overseer, have charge of each camp, the bookkeeper, cooks and all other help being convicts. There are at present six convict road camps in the State, with from 25 to 100 men each. They have built the best mountain roads in the United States: The Colorado Springs-Cañon City Road, the "Sky-Line Drive" to the top of the Royal Gorge, Boulder Cañon Drive in Boulder County, roads in the Cañon of the Big Thompson, the Cañon of the Poudré, and the Fall River Road from Estes Park to Grand Lake.

"Under the Colorado law these camps are maintained jointly by the county where the work is done and the State Highway Commission."

FALL RIVER ROAD

An idea of the character of this road work in the Rockies, of the methods employed and of the difficulties met, may be gained from an account of the Fall River Road.

This highway is being constructed as a link between the county roads in Larimer and Grand Counties. These existing roads are between 11 and 12 miles apart, as the crow flies, but between them lies the Mummy range and the great ridge of the continental divide. To cross these

*1748 Broadway, Denver, Colorado.

Convict workmen's camp on Fall River Road, Winter quarters

mountains, the road follows the Fall River to the west and north, swings in a semicircle to the Little South Poudré, up to Poudré Lake, 10,300 feet high, and then, crossing the Medicine Bow range, drops rapidly into the Grand River country. The distance, by this circuitous route, is 21.5 miles. The road starts at Sheep Lakes, eight miles west of Estes Park. It is about 8,500 feet in altitude at either end, while its highest point is reached near Mt. Chapin, eight miles west, where it crosses the Mummy range 11,360 feet above sea level, and requires one and one-half miles of road to win half a mile in total distance.

The Fall River road will afford a more direct route than the present one from Grand Lake and Grand County to Denver; and will thus shorten, by many miles, the distance by highway from Denver to Glenwood Springs and Grand Junction. The new road is laid out on easy grades for carriage and automobile, and will form a section in a circular route of 230 miles, including Estes Park, Grand Lake, Idaho Springs and Denver, that will be of wonderful scenic beauty.

The Estes Park-Grand Lake road is being financed by the State Highway Commission, and by Larimer and Grand Counties, with some aid from the forestry department of the federal government. Its estimated cost is $60,000. Sixteen miles lie in Larimer county and 5.5 miles in Grand County.

The Larimer County work began early last spring, under the direction of Superintendent Thomas Lancaster. The working force consists of 40 convicts from the state penitentiary at Cañon City. Their winter camp is shown in the photograph on this page.

The first mile of road, west of Sheep Lakes, is chiefly earth construction. From this point west to the county line, however, with the exception of an occasional mile or two of dirt and boulders, the work is in rock, aggregating between 150,000 and 175,000 cubic yards. The finished


Sullivan Portable Compressor outfit used on the Fall River Road

road is 16 feet wide and surfaced with a cushion eight inches thick, of sand and clay mixed. The cuts in solid rock are as much as 20 feet deep in some places, while in others, 30-foot fills have been necessary.

The rock is a close grained, very hard grey granite, in which hand drilling has proved very slow and laborious. The rate of progress was so slow, in fact, that the Commissioners of Larimer County deemed it advisable to install a portable drilling outfit.

A Sullivan "WK-3" portable gasoline engine-driven compressor and a "DC-19" Sullivan hammer drill were purchased for this work. This plant consists of a standard Sullivan 8x10 compressor, direct-connected through gear and pinion to a 20 h.p. gasoline engine, the whole mounted on a structural steel truck. The air receiver and gasoline tank are slung under the truck frame. The engine and compressor cylinders are cooled by the evaporation of water from cast iron hoppers. This method of cooling obviates the necessity of using pumps and large water tanks and thus makes the unit much more compact and simple.

This outfit has been in use on the "Fall Road" road since April, and notable economies have been secured. The average footage for the one drill has been 60 feet per eight-hour shift, which is an unusually good record, considering the hardness of the granite. The fuel used averages ten gallons of gasoline per shift. The outfit is shown at work in the cut on this page, and on page 862, the hammer drill, weighing 44 pounds, is shown. This picture gives an excellent idea of the nature of the rock excavation accomplished with this light tool. In a cut like this holes are bored 8, 10, and 12 feet deep, without difficulty. From this depth, the drilling ranges down to "block-holes," one and two feet deep, for breaking up fragments too large to be readily removed.

A noticeable advantage of the hammer drill over the hand method is in the saving of steel; it usually required about 18 hand steels to drill a "plug" hole a foot deep, while the hammer drill would put in two holes a foot deep with one steel.

On the basis of the performance of this one-man drill, Superintendent Lancaster estimates that one machine takes the place of about 15 hand drillers in this kind of rock and makes possible a corresponding increase in the rate of progress of completed road.

It is interesting to note the great economy gained in using an outfit of this kind, even when labor is figured at such a low rate as 98 cents per day (see below). The saving in cost of construction obtained by the use of this plant, enables the county to complete several miles more of road each year with the available funds, than would be possible without it.

The construction outfit includes six head of horses, one team being used for hauling supplies to the camp and the

other two for clearing timber from the right-of-way and moving the large rocks. A blacksmith shop is maintained for drill sharpening and repair work.

The average cost per man per day for food is 30 cents. The total cost per man per day, which includes all costs of the work, powder, horse feed, salaries, and all other expenditures, averages 98 cents per day per man.

Under the convict system, the State furnishes the men and clothes them, while the county is responsible for their maintenance and transportation.

As stated above, about forty convicts are used on this work, who live in a camp under the direct charge of the superintendent and his assistant. Never, at any time, are citizen guards in the camp, and the men have no restraining influence except their own sense of honor. How well they respond to this confidence is evidenced by the fact that desertions are thus far unknown.

The clothes worn by the convicts are either khaki or blue woolen cloth, and the shirts are of as many different kinds as you would find on as many citizen laborers. These shirts are prison-made and are kept washed and in repair by a man detailed for this work.

The regulations of the camp are few and simple; a night guard is maintained, who in this particular camp is an Austrian, serving a sentence for murder. All lights must be out at nine o'clock except on Saturday night, when an extra hour is allowed for the weekly bath and shave. The barber, as well as the cook, is serving a sentence for murder. In fact there are nine men in the camp who are "doing" time for this crime, besides two "hold-up" men.

The present base-ball ground is about three miles from camp, and every Sunday the entire camp participates in the greatest American sport. It is not too much to say that the convicts are contented. The first five miles of the Fall River Road were completed November 1, when the year's work ceased, to be resumed May 1st next.

ROYAL GORGE ROAD

The "Royal Gorge" road referred to in this article, is being built from Cañon City to Cotopaxi, along the bank of the Arkansas River, on the opposite side from the Denver and Rio Grande Railroad, and includes about twelve miles of road which is, literally, to be blasted from solid rock. On this work, Fremont County is using one hundred convicts in charge of Captain Charles Baldwin, and this county has also purchased two Sullivan 20-horse-power "WK-3" portable compressor outfits and hammer drills, which are duplicates of the plant used on the Fall River Road. The system of handling the convicts on this road is identical with the system used in Larimer County.

The Commissioners of Garfield County have also purchased recently a similar Sullivan "WK-3" drilling rig, for use in excavating rock during the coming season, in widening the wagon road in the canyon of the Grand River, east of Glenwood Springs.

Sullivan Portable Air Compressor used in Colorado road work

The writer wishes to acknowledge with thanks, the assistance given in securing data and photographs, by Superintendent Thomas Lancaster, of the "Fall River" camp; Captain Charles Baldwin, of the "Royal Gorge" camp and Senator

Thomas Erhart, State Highway Commissioner.

The illustrations are supplied by the courtesy of *Good Roads*.

ST. LOUIS SEWER TUNNEL PLANT

The three successful contractors for the 18,000-foot section of the Mill Creek intercepting sewer, recently let in St. Louis, are Messrs. Brocklehurst & Potter, of New York, James T. McMahon Construction Co., St. Louis, and Thomas Connor & Sons, St. Louis. The tunnel is to be driven through medium soft lime rock with a section of 19½ x 19 feet. Brocklehurst & Potter have sunk two shafts, one at Armstrong Street, 95 feet deep, 11 feet of which is in dirt; one at Ewing Street, 84 feet deep, 23 feet of which is in dirt. At 12th Street, a shaft, 87½ feet deep, of which 40 feet in dirt, has been sunk by the McMahon Co. The second McMahon shaft is at 6th and Rutger Street, 38 feet deep. Thomas Connor & Sons have put in two shafts, one 98 feet deep at Theresa Street, of which 95 feet is in dirt; and one at Tamm Street, 63 feet deep, 35 feet in dirt. Some quick sand was encountered in this last shaft and sheet steel piling was used down to the rock. All these shafts are concreted throughout.

The equipment purchased for this job by all three contractors consists of Sullivan air compressors and drills. Six belt driven two stage compressors are in use, five having a piston displacement of 1,015 cubic feet per minute and one having a piston displacement of 628 cubic feet per minute. These are being operated by short belt drive from electric motors. It is interesting to note that the rock drills, of which 46 are in use, are all of the Sullivan "FF-12" 2⅝-inch LITEWEIGHT pattern with water attachment. It may be remembered that this is the size and make of drill used so successfully on the Mount Royal Tunnel, of the Canadian Northern Railroad, at Montreal, and with which the present American tunnel record for a single heading in hard rock, was made there last year (810 feet of 8 x 12 heading in hard limestone in 31 working days.) About 15 Sullivan Rotators or self rotating hammer drills were employed by the contractors for sinking their shafts, and are now used in block holing, trimming and other light drilling work.

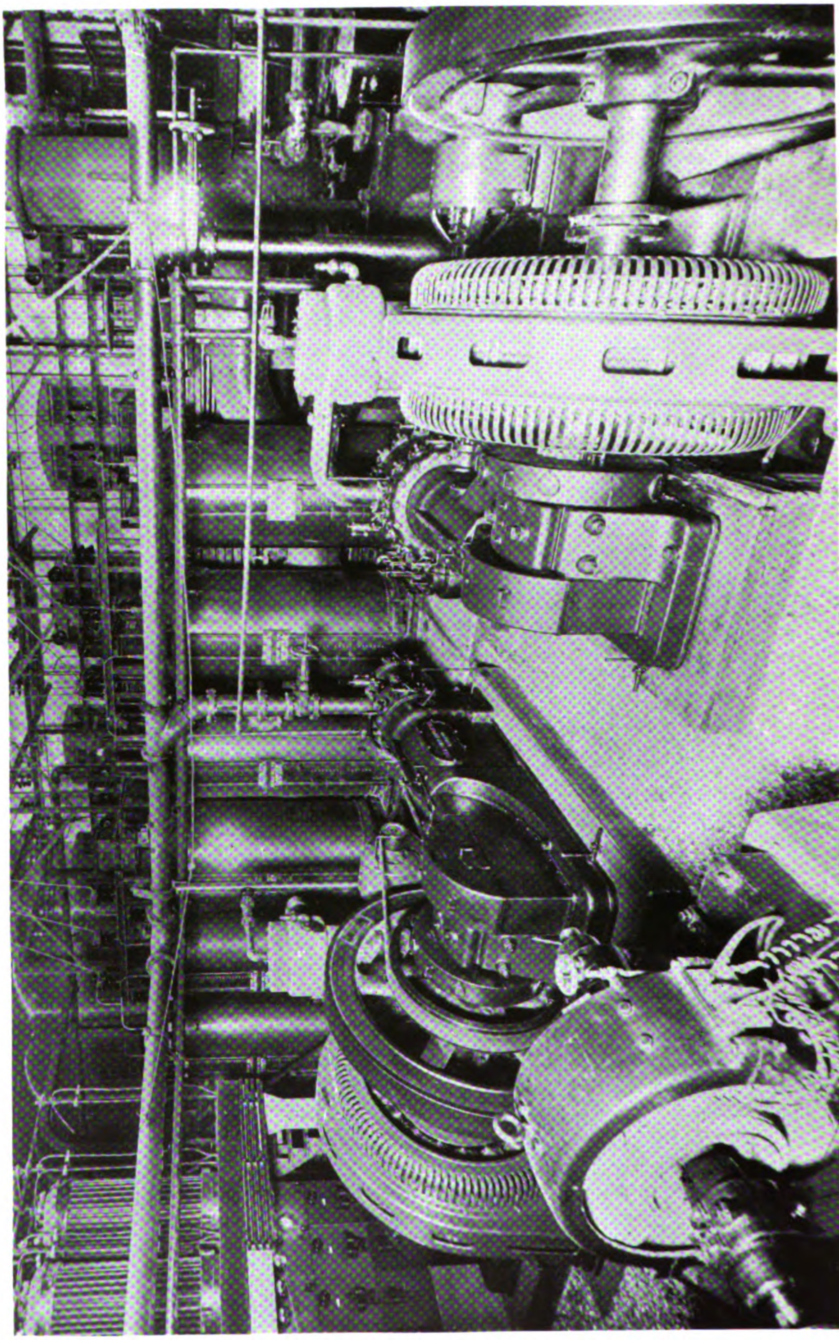
NAVIGATION WITH A SULLIVAN DIAMOND DRILL

The accompanying photograph shows what is claimed to be a novel and unique use for diamond drilling outfits. As will be seen, it consists of a portable boiler mounted in a scow for operating a Sullivan class "H" diamond core drill. The machine, with swivel head swung over to a nearly horizontal position, was employed to drive a paddle wheel at the rear end of the scow. The following quotation from a letter from Mr. J. M. Heizer, diamond drill operator for the U. S. Reclamation Service, will be interesting. "This picture was taken on the Colorado River, just below the junction of the Green and Grand, October 25, 1914. The drill was one that had been in use by me for the U. S. Reclamation Service in search of bed rock for a dam site.

"The scow shown in the picture made a 100-mile trip up the Green in four days, with the "H" drill driving the paddles."

Sullivan Diamond Drills have been extensively used by the United States Reclamation Service in most of the western states.

Sullivan Diamond Drill as a Marine Engine



Sullivan "WN-2" Air Compressors at Hannibal, Missouri, driven by electrical energy from the Mississippi River

Atlas Portland Cement Works, Hannibal, Mo.

AIR POWER FROM THE MISSISSIPPI

One of the first private industrial plants to be operated by power from the Keokuk dam on the Mississippi River is that of the Atlas Portland Cement Company, at Hannibal, Missouri.

In August, 1913, the steam-driven air compressors of the Atlas Co. were replaced by three Sullivan "WN2" cross-compound air compressors, with 26 and 15¼ by 18-inch cylinders, each machine having a capacity of 2,000 cubic feet of free air per minute. These compressors are directly connected to General Electric 400-h.p. synchronous motors running at 187.5 r.p.m., using three-phase, 25-cycle, 220-volt current. This current is stepped down at the transformer station from a voltage of 33,000, at which tension it is transmitted from the Keokuk plant, on the Mississippi River, about sixty miles distant.

An average receiver pressure of 100 pounds is maintained by means of total-closure unloading valves on each machine. These unloading valves are operated automatically, so that a five per cent regulation is obtained in receiver pressure.

To supply the present demand of the plant, the energy input to the compressors will average about 12,000 kilowatt-hours per day. The principal use for this air is found in a blast supplying pulverized coal to rotary kilns and for drills in the limestone quarry. Air is also supplied to the machines in the blacksmith shop for operating hammers, hoists, drills, etc., and there are outlets at convenient points throughout the plant for cleaning motors and other apparatus.

This installation was made by the Stone & Webster Engineering Corporation, of Boston, and is the first large compressor plant of its kind operated by power from the Keokuk plant.

The illustration shows the motors direct connected to the crankshafts of the compressors. The large stepdown transformers for the compressors and for other purposes in the works are shown at the rear and side of the room.

We are indebted to William H. Baker, superintendent of the Atlas Co. for the foregoing data.—(*Power.*)

Compressed air for the construction of the Keokuk dam and power house was supplied by two 2,500-foot Sullivan air compressors, of the "WX," cross compound corliss steam and two-stage air pattern. The cycle, from "Sullivan air power" to water power to electric power to Sullivan air power again, is therefore complete.

The use of Sullivan drills, compressors and channeling machines on the Keokuk dam was described in MINE AND QUARRY for August, 1911.

Since the last issue of MINE AND QUARRY a branch Sullivan sales office has been established at Juneau, Alaska, in charge of Burt B. Brewster. Air compressors and drills and their parts are carried in stock, at the New Brunswick Building.

Sullivan Diamond Drills

are the most accurate and reliable tools for mineral prospecting. They have been known and used for forty years, the world over.

Sullivan "E" Drill set up for an angle hole over a narrow Mexican *Arroyo*

Diamond Drills are the most satisfactory drills for removing cores. In many formations they are the *only* drills that can do this work.

The best and cheapest Diamond Drills are "Sullivan". *Accept no substitute.*

Built in 27 stock patterns, for depths up to 6500 feet, to remove cores of any desired size.

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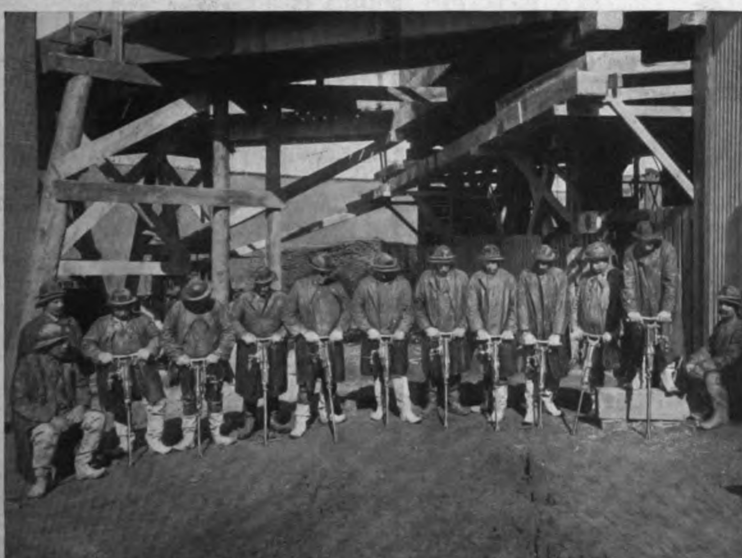
MINE AND QVARRY

REG. U. S. PAT. OFF.

VOL. IX, No. 2 JANUARY, 1916 WHOLE No. 30



Sullivan Rotators at the Woodbury Shaft, Ironwood, Michigan

A MECHANICAL DRILL SMITH

DEEP MINING WITH "IRONCLADS"

NOW THE AIR FEED DRIFTER

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MINE AND QVARRY

REG. U. S. PAT. OFF.

Vol. IX, No. 2 JANUARY, 1916 Whole No. 30

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company.

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Readers are requested to notify MINE AND QUARRY of any correction or change in address.

At mines, quarries, and on public work all over the world, the rock drill holds a position of great importance and responsibility. On it depend the rapidity and economy with which the rock is broken and the output secured or progress won. Managers and superintendents devote much effort to selecting drills suitable for their working conditions and much expense in keeping them in repair after they have been selected. Manufacturers are constantly striving to produce drills still more economical of labor, power, and upkeep, and of still greater cutting speed.

With all this expenditure of effort and money on the drilling machines, it is curious that greater attention has not been paid to the bit that does the actual cutting. If the steel is not of proper strength and toughness, if the bit is not made of proper shape, or gauge, or tempered correctly, the drills themselves are handicapped. A machine for forging bits by the hammer process is described in this issue of MINE AND QUARRY. It possesses many desirable elements which aid in solving the drill bit problem.

A few months ago a contributor to one of the mining weeklies called attention in an ingenious vein to the lack of labor efficiency connected with the use of drifting drills. Taking a one-man piston drill as an example he showed, by a sketch made largely of "hen tracks," the amount of walking around the drill which the average machine runner has to put in in the course of a round of holes in order to feed the drill down, feed it back again, change the steel, shift the mounting, and do all of the other work that must be gone through with while the machine is not actually hitting the rock.

At the very time that this article appeared, drifting drills of a new type had been for some months in successful use, which seem as if made to answer every criticism brought by this writer against the old style drill.

This new device for drifting is a combination of all the really great improvements that have been made in drilling machines during the past 15 years. The first of these improvements was the introduction of the so-called one-man piston drill, and the new drifter is very distinctly a one-man tool. A second improvement came with the introduction of hammer drills, and the new drifter is a hammer machine. A third great improvement was the employment of a water jet, discharged through hollow steel to clean the drill hole of its cuttings, and a water jet is one of the new tool's advantages. A fourth improvement, of great importance in the mining field, was the air feed as applied to stoping drills, eliminating the feed screw and shell altogether; and the new drifter is an air feed machine. Positive air feed, both forward and backward, adjustable control of the rate of feed, and self-alignment of the drill and steel are the chief advances embodied in this new device, which is described elsewhere in this number.

RAPID SINKING AT THE NEWPORT MINE

By J. M. Broan*

[The Newport Mining Company, at Ironwood, Michigan, on the Gogebic range, has long been known as the largest underground iron mine in the state, as well as a pioneer in adopting modern methods in a mining district where organization and mechanical efficiency have always been maintained at a high level. The equipment and methods used in sinking the company's new Woodbury shaft, reflect the most up-to-date practice and a high degree of engineering skill and ingenuity. By these means a record progress for the Lake Superior district, if not for the entire country, has been secured.

The article which follows has been abstracted from a paper read by Mr. J. M. Broan, Mining Engineer of the Newport Mining Company, before the twentieth annual meeting of the Lake Superior Institute of Mining Engineers, in September, 1915.— Editor.]

The Woodbury shaft, being sunk by the Newport Mining Co. at Ironwood, Michigan, is situated 100 feet from the contact between the iron-bearing formation and the underlying strata. The shaft is vertical, with its length at right angles to the strike of the formation. The over-all dimensions are 13 feet 1 inch by 21 feet 1 inch, having six compartments, which will accommodate two skips, two cages, one ladder-way, and piping. The first 100 feet of sinking was in quartzite; from 100 to 715 feet in depth there were alternate strata of gray and red slates and quartzite, below which is granite. The temporary head-frame is 60 feet high, with the trestle so arranged that it is possible to hoist rock in any of the compartments and dispose of it by means of a haulage-motor and car to a common stockpile. During the sinking of the first 700 feet, the hoisting was done in three compartments by means of a single-drum hoist, operated by a 50-h.p. motor and a double-drum hoist, operated by a 70-h.p. motor. While sinking this portion of the shaft, a duplex horizontal steam-hoist was being installed for handling the cages in the permanent layout, and by July this was used to operate a bucket in the fourth compartment.

Excavation was begun on March 1, 1915, and at the time of writing (July 27) was 901 feet in depth. The maximum footage per month was 201 and the minimum 167 feet.

Three belt-driven, cross compound compressors, each driven by a 50-h.p. motor, furnish air at 90 to 100-pound pressure to 12 hammer drills of the self-rotating type, weighing about 40 pounds each. The air-line is a 6-inch wrought-iron pipe for permanent use. The equipment is in some respects different from ordinary practice.

"AIRSHIPS" IN THE SHAFT

Two "headers" (known locally as "airships," see page 872) are used for distributing air to the drills, each of which will accommodate seven hammer drills and one blow-pipe. The sketch on page 871 shows the "airship." "A" is a casting 9 inches in diameter, bored out in the center, and having a bolt circle of a standard 4-inch flange.

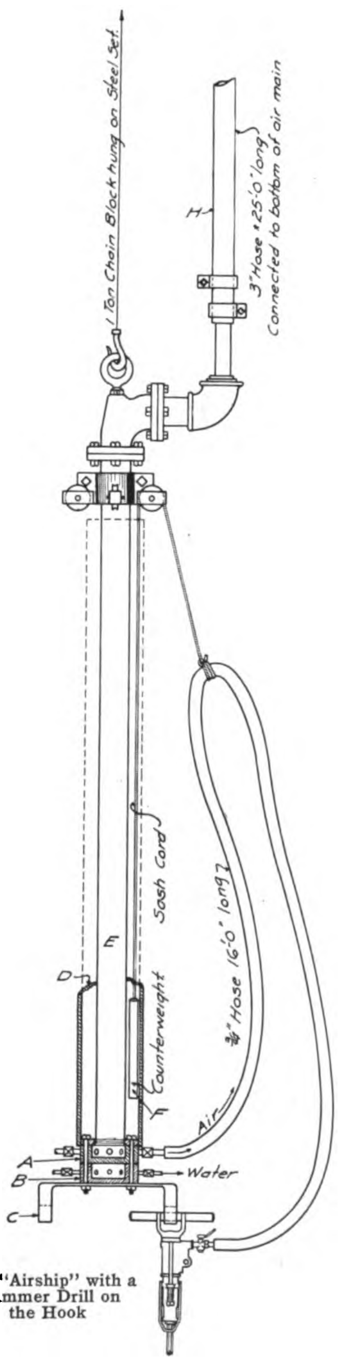
Eight holes evenly spaced are drilled in the sides and tapped for ¾-inch nipples, to which the machine hose connections are made. "B" is a duplicate of "A" with the exception that the holes for the nipples are of different size. There are seven ½-inch connections and one 1-inch, the latter being an inlet for the water and the others for water discharges to the drills, to be used only with water tube type drills. The hooks or hangers marked "C," are made of ⅜-inch by 2-inch strap iron. There are four straps with a hook

*Mining Engineer, Ironwood, Michigan.

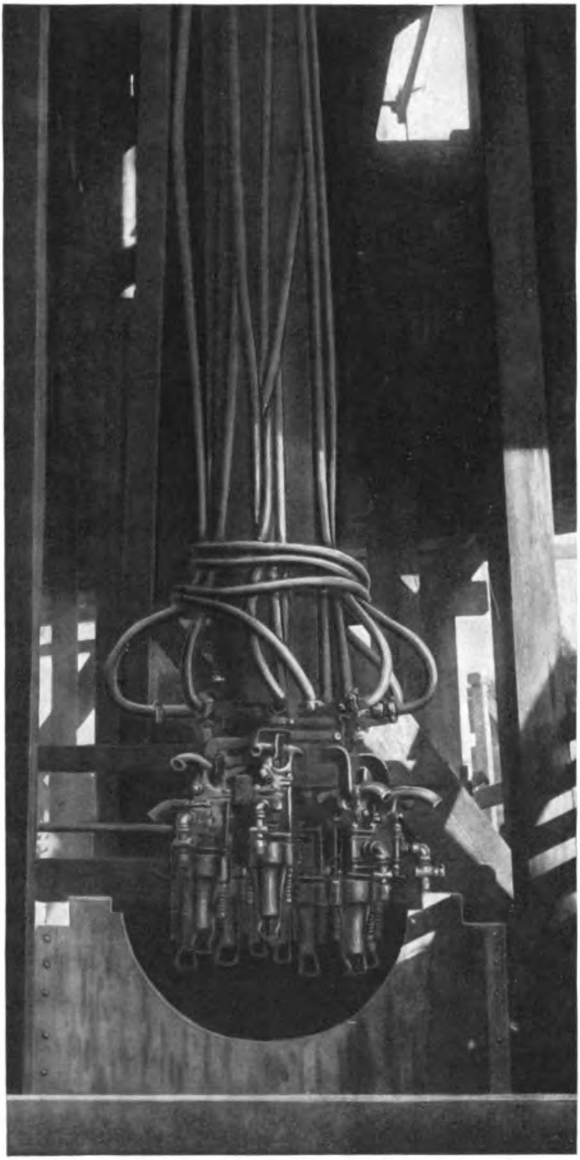
on each end. "A," "B," and "C," are all held together by four ¾-inch bolts passing through the four-inch flange at the bottom of the four-inch air pipe "E." The ell at the top is made special, with a lug cast on it to accommodate the one-inch eye bolt by means of which the "header" is suspended. "D" is a nine-inch pipe which serves as a casing to enclose the counter-weights "F." When not in use the "headers" are hung off to one side, in the headframe, and can be easily lowered by means of a sling beneath the bucket. While in use they hang on a small chain-block fastened to the bottom shaft set. By means of this chain-block the apparatus can be brought to any desired height, the adjustment being allowed by use of a three-inch air hose, "H," which connects to the air main; the bottom of which is always far enough up the shaft to avoid any severe blows during blasting. One of these outfits can be taken from its position on surface and placed on the chain-block below ready for drilling in less than five minutes, only one connection being necessary.

While in the softer slates water tube pistons were used and air blown through them in place of water. A short piece of ⅜-inch rubber hose, shown at "A" in the sketch, delivered air from the ¾-inch air hose to the tube connections. Later, when drilling into the granite, the drilling speed was not as great, and it was found that sufficient air could be supplied through the ordinary piston to clear the choppings from the drill. The water-tube pistons were then replaced by the ordinary pistons, and the by-pass hose disposed of, thus giving greater efficiency in air consumption, but no noticeable decrease in drilling speed.

The steel, which is ⅞-inch hollow hexagon, is made up into lengths varying by 1 foot changes from 12 inches to 10 feet, with a ⅛-inch difference in gauge for each drill; the first bit being 2¼ inches. Until the granite was reached, the four-point or cross-bit was used, but the wear



The "Airship" with a Hammer Drill on the Hook



Sullivan Rotators on the Woodbury Shaft "Airship"

difficulty was encountered, especially in the stratified rocks with fissured holes and stuck drills. Rather than abandon a hole, much time was often spent in freeing a drill. It was here that necessity led to the conception of two bit-pullers. In case only a short portion of the steel emerged, a long gooseneck was used, while if two feet or more of the drill remained out of the hole, a shorter puller could be applied. In either case an inverted hammer drill supplied the necessary power to extract the drill.

While in the soft slates 10-foot drills were used with very little difficulty and sinks measuring as deep as nine feet have been blasted successfully. About 470 lineal feet of drilling was required per cut in these slates and this could be completed in from four to five hours. In the hard quartzite, dike, and granite the gauge of the steel would not hold up long enough to permit the use of any drill over eight feet long.

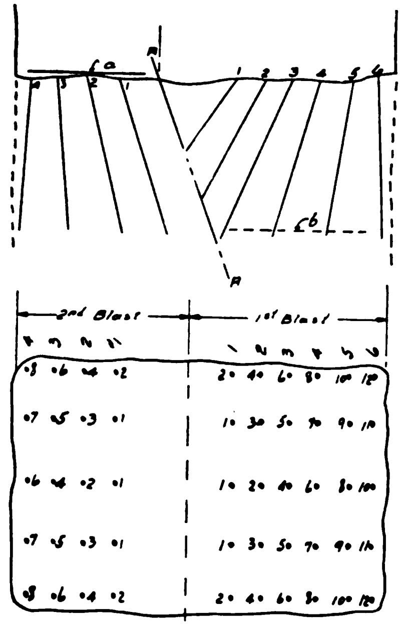
In these rocks about 425 lineal feet of drilling is necessary, which can be drilled in from seven to eight hours. The breaking of the holes is dependent entirely upon their arrangement and the order

on the gauge became such as to warrant a change if something more serviceable could be found. It was then that the "Carr" bit was tried out. Considerable

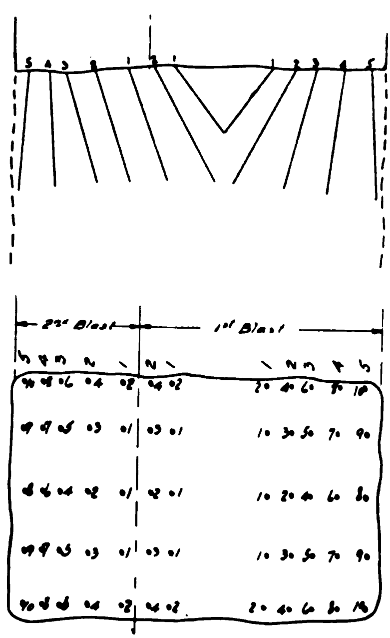
in which they are fired. The upper sketch on page 873 shows the plan and section of the arrangement and order of firing used while in soft slates. Line "AA" repre-

sents a bedding plane on which the rows Nos. 1, 2, and 3 on the right were bottomed. The shaft was blasted in two separate blasts, the first being made on the right, and the holes blasted in the order numbered in the plan. Three holes marked No. 1 were fired simultaneously with No. 6 electric blasting caps. The exploders in the remaining holes were made up of No. 8 caps and electric delay fuse igniters.

A different arrangement of drilling and order of firing was found more satisfactory in the granite. The lower sketch shows two rows of holes marked No. 1, which are drilled about five feet deep at an angle of 60 degrees; then two rows marked No. 2, about eight feet deep at an angle of 70 degrees. These four rows of five holes each comprise the cutting holes, which are fired in the order numbered in the plan. The six No. 1 holes are fired with No. 6 electric blasting caps and the others with No. 8 caps and electric delay fuse igniters.



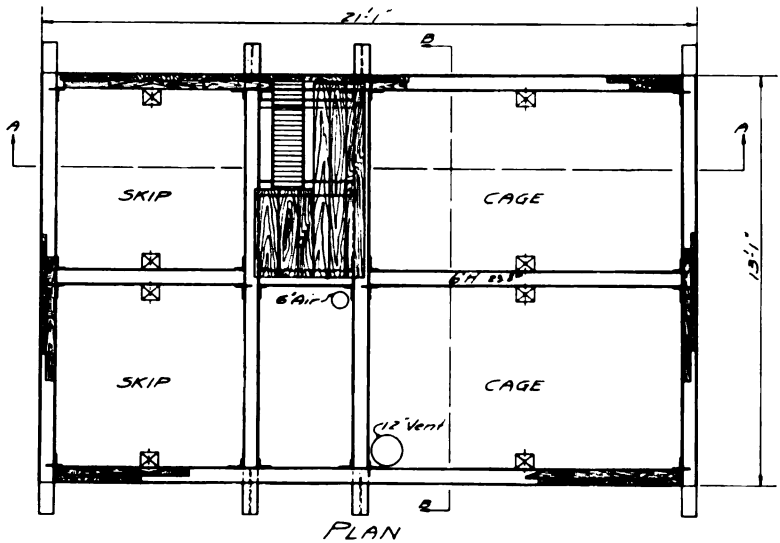
Arrangement and Order of Firing of Holes in Soft Slate



Arrangement and Order of Firing of Holes in Granite

BLASTING

Since the steel used is only ⅞-inch diameter, the bottom of a deep hole is very small and cannot contain sufficient explosive to break the burden in a satisfactory manner. To offset this disadvantage without drilling more holes, two or three sticks of 100 per cent blasting gelatine are placed in the bottom of each hole. The remainder of the charge, with the exception of the cartridge containing the detonator, is 80 per cent blasting gelatine. Experiments by the Du Pont Company have shown that 60 per cent nitro-glycerine gives a maximum efficiency for speeding the action of a charge, and for this reason a single cartridge of this strength is used to contain the detonator. It is placed as near the top of the charge as is considered safe from being cut off by the breaking of an adjacent hole. Cartridges of sand are used for tamping. An average of 26½ pounds of explosive per foot of shaft has been used in the first 800 feet, or about 1 pound



Plan of Woodbury Shaft

for every 13 cubic feet of excavation. Du Pont crescent fuse was adopted, after experiment, in preference to double or triple tape fuse, on account of its greater pliability when cold. All exploders were made with fuse of the same length, and these, when the holes had been charged, were cut so as to fire them in the order desired. The ends of the fuse were then placed in a pasteboard box containing black powder. An electric fusee ignited this powder, which, in turn, lighted all the fuse simultaneously. Several boxes were employed, thus requiring shorter fuse than if a single box was placed in the center of the shaft. From 30 to 35 holes is about the maximum number fired at any one time. The switch for closing the circuit is locked in a small cupboard on surface, and the key is kept by the shift-boss during the preparation of the blast. Every igniter is tested with a small galvanometer before being used. After a blast the smoke is cleared by a draft forced through a 12-inch pipe by a 7-h.p. fan on surface. At first the fan was used to draw the smoke out, but by reversing the current, less time was required to clear the smoke.

MUCKING

During the first 700 feet of sinking, the broken rock was hoisted in three buckets, each of a capacity of 26 cubic feet. In order to make shoveling as easy as possible, steel plates have been used as sollars with considerable success. In the top sketch on page 873, "A" shows the position of these plates, when the first blast is made. The breaking of the holes in this blast has a tendency to throw the rock to the position of the plates. In the second blast of the same cut the plates are placed in position "B."

SHAFT CONSTRUCTION

The essential features of the shaft construction are shown in the accompanying sketches, in plan and elevation. The steel sets are made of six-inch "H" sections (23.8 pounds) and hung on studdles made of 3 x 5-inch angle iron. Sets are spaced six-foot centers in the slates, and eight-foot centers in the granite. At about every 100 feet of shaft a bearing set is place under the shaft set. These are supported temporarily by large spruce sprags about 12 or 15 inches in diameter;

which will be replaced by concrete. The staging used to work on is made of 2-inch hardwood plank, supported by pieces of 2½-inch extra heavy pipe. These pipes are hung in the form of slings by means of pieces of ⅜-inch steel rope fastened to the ends and hooked over the flange of the "H" section on the shaft set above.

Guides are made of 6-inch by 7-inch pine, dressed, and are framed to span two 8-foot sets or three 6-foot sets. Laths for lining the shaft are made of 2-inch hardwood. These will also serve as forms for concreting when sinking operations are completed.

ELECTRIC WIRING

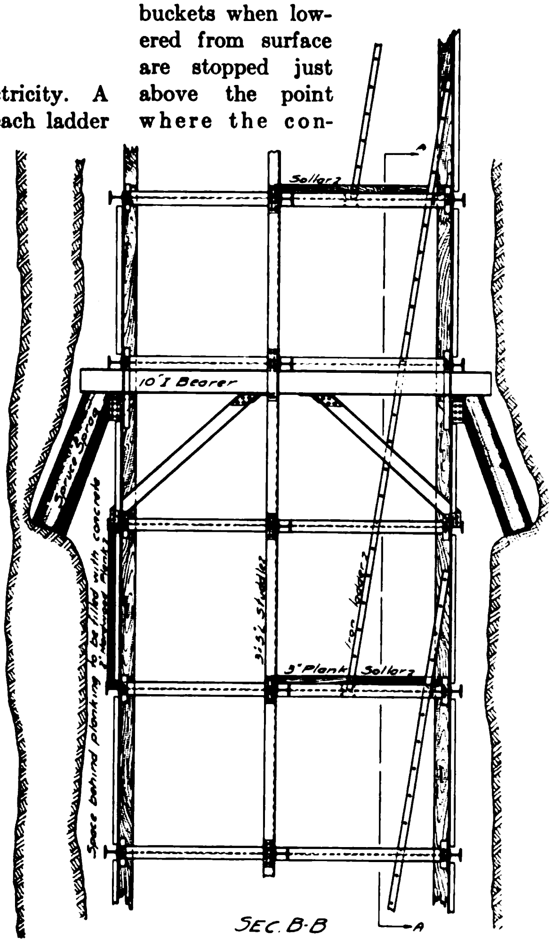
All lighting is done by electricity. A single lamp is placed under each ladder sollar to light the ladder to the sollar below. At the bottom of the shaft, two clusters of four lights each are hung, one below the staging to give light to the miners and one above to give light to the construction crew. An electric signal system is used, the wires being run down the east side of the shaft beneath the ladders. By means of a jumper connected to a common return wire, either signal bell can be rung from every sollar.

LABOR

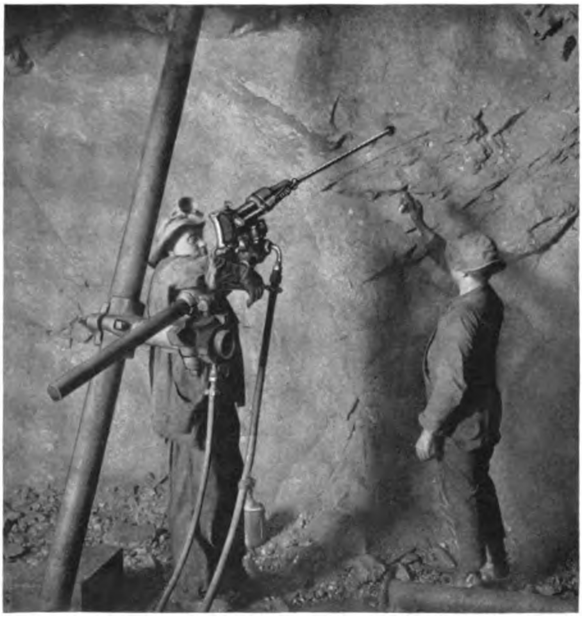
The men employed in the shaft are as follows: One shaft captain, three shift bosses, 36 miners, 11 construction men, one electrician, four landers, two motormen, four hoist engineers, a total of 62 men.

SAFETY

The first step along the line of accident prevention was the use of hard hats. In order that no excuse can be made, every man is furnished with a hat made of felt treated with resin and shellac. These hats are very hard and will resist a severe blow. No person is allowed to enter the shaft without one. Danger signs are placed in conspicuous places warning loafers to keep out. Movable sollars made of steel plates and operated by levers, are placed over the two compartments most used for loading supplies. When the bucket hangs at the brace the lever is thrown and the plates close in around the bucket, making practically a complete cover of the compartment. All buckets when lowered from surface are stopped just above the point where the con-



Sectional View of Woodbury Shaft Timbering



Sullivan Pneumatic Feed Drifter in the Newport Mine

for drilling in the ore body. These tools use solid, twisted steel, with "fish-tail" bits. This page shows a Sullivan Rotator at work in the Newport Mine, on the new style pneumatic feed mounting, described elsewhere in this issue.

The water jet attachment has demonstrated its usefulness at this mine in connection with piston drills as well as with hammer drills. Sullivan "FF-12" "Liteweight," 2⅝-inch machines, thus equipped, having been in successful use for more than a year.

struction crew is working and are rung down from there by the men below.

It may be added to Mr. Broan's paper that the ultimate depth of the Woodbury shaft is to be about 2400 feet. On December 1, the shaft had reached a depth of 1664 feet, having been sunk at an average rate of 187 feet per month since August 1.

SULLIVAN EQUIPMENT

The shaft sinking equipment included 12 Sullivan Water Tube Rotators, which are shown ready to go underground, on the front cover of this issue, and on the header, or "air-ship," on page 872. Sullivan auger type rotators are also in use underground

SHARPENING DRILL STEEL

All drill steel at the Newport Mine is sharpened mechanically. There are two machines, one of which is a Sullivan hammer-type compressed air sharpener, installed last May. This sharpener has been in continuous operation 24 hours per day, as the mine works two shifts. All of the shanks and nearly all the bits required are made on the Sullivan machine. This type of sharpener is described in another article in this issue.

The editor's acknowledgments are due Mr. Broan for information and the loan of drawings used in this article.

AMERICAN DRILLS IN AN ITALIAN TUNNEL

*By Mario Axerio, Civil Engineer

A private Italian water power enterprise of some interest has been under construction for two years past, near the town of Lucca, in Tuscany. This project consists of an aqueduct about 19,700 feet long, which will take its supply from the Serchio River. The aqueduct is

*Turin, Italy. Corso San Martino, No. 4

almost entirely in tunnel, there being two tunnels, one 13,100 feet long and the second, 3,300 feet in length.

The power derived from this source will be used for lighting the cities of Lucca, Pisa, Leghorn, and other smaller towns in Tuscany. This enterprise is being promoted by the Societa Ligure Toscana di Elettricita, Limited, of Leghorn. The contractor is Manotti Falzoni, of Milan.

The aqueduct is situated about 28 miles from Lucca. The longer of the two tunnels has one of its portals near Castelnuovo di Garfagnana, while the shorter is close to Gallicano.

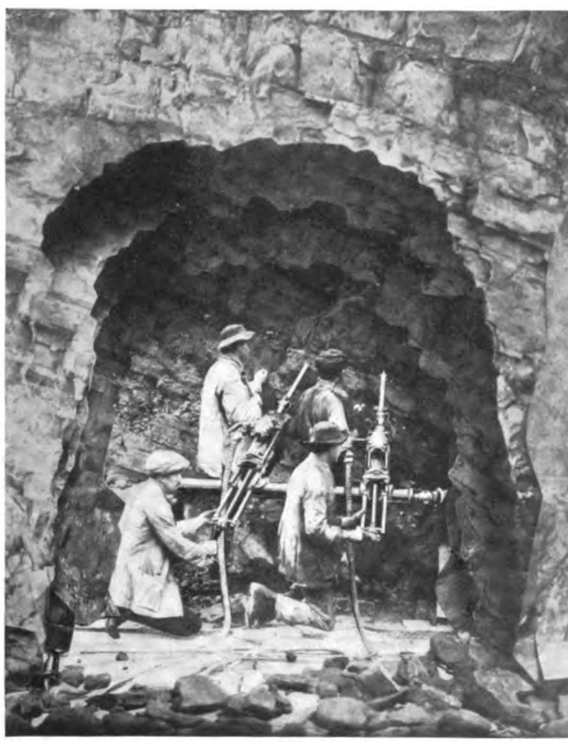
The power plant for suppyling air to the drills on both tunnels consist of two Sullivan "WJ" type cross compound air compressors, belted to individual electric motors, and located one at each end of the Castelnuovo tunnel.

These compressors have low pressure cylinders 14 inches in diameter, high pressure cylinders 9 inches in diameter, with a common stroke of 10 inches, at 190 r. p. m. They have a sea level rating of 338 cubic feet of free air per minute each, compressed to 100 pounds per square inch. The compressors discharge into a vertical air receiver eight feet long by 36 inches in diameter located just outside the engine room. A corner of the engine room at Castelnuovo is shown in the small cut on page 878, and the location of the power plant, on the hilly bank of the Serchio River, is seen in the lower illustration on page 878.

A dam at this point, in the canyon-like valley, impounds water which will pass through the tunnel and be returned to the river lower down the stream after generating the power required of it.

The Castelnuovo tunnel is 8 x 7 feet in area inside the concrete lining, but the variety of the ground encountered has caused the size of the bore to be changed from time to time to facilitate driving and timbering. Although the tunnel pierces a mountain of some height, the ground encountered is by no means uniform and solid, but ranges from soft fire clay to limestone, including a considerable amount of argillaceous schist.

The method of advancing the tunnel has been to drive a bottom heading about 6½ x 6½ feet, and then take down the roof and widen out to the full section. The Castelnuovo tunnel has been driven from both ends. One of the headings en-



Sullivan Liteweight Drills driving the Castelnuovo Tunnel, near Lucca, Italy

Power house of Menotti Falzoni, Castelnuovo Tunnel, showing one of the Sullivan "WJ" Air Compressors

countered very soft material, so that constant timbering was required. In the other heading, shown in the cut on page 877, Sullivan "FF-12" 2¼-inch Liteweight Piston Drills have been used for drilling. These drills were mounted on a heading bar, and put in a round of eight holes to an average depth of five feet. Where the rock was harder, additional holes were drilled. The two back holes were drilled first, looking up, from over the bar. Next the center cut hole and the two rib holes were drilled, also looking up a little. The drills were then swung under the bar and the three lifters put in, looking slightly down. The rate of progress has been irregular, due to the bad ground, which necessitated continual timbering. Two bad caves in the stratified clay caused considerable loss of time. Three shifts of eight hours each are worked.

In the harder rock, a Sullivan "DA-21" stoper has been employed for drilling the roof behind the heading. American drills have also been used to a limited extent in a stone quarry, from which material is obtained for use in the concrete lining.

Two benzine locomotives are used for hauling the muck cars out of the tunnel.

The shorter tunnel, 3,300 feet long, at Gallicano, is also being driven with Sullivan Liteweight Drills, by the bottom heading method, although for the first 100 feet a top heading was driven, and the bench subsequently raised.

The project described above is making good progress, and its completion is looked for about the middle of 1916. These notes were furnished by Signor Mario Axerio, civil engineer, of Turin, Italy, and the photographs were supplied by the courtesy of the contractors, Menotti Falzoni, of Milan, to both of whom acknowledgment is tendered.

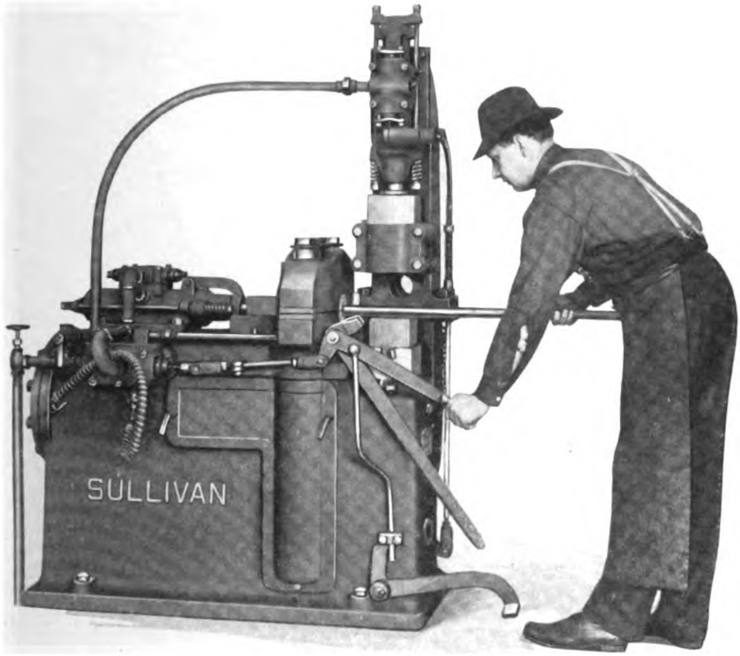
Portal and power house of the Castelnuovo Tunnel

A MECHANICAL DRILL SMITH

CONTRIBUTED

One of the most carefully practiced duties of the foreman or superintendent in mine, quarry or public work, should be to see that his rock and hammer drills have an adequate supply of drill steel that is properly gauged, shaped, shanked and tempered.

Drill sharpening machines have been in use for a number of years, and possess many advantages over hand smithing in



Sullivan Drill Sharpener with steel in the clamping dies, being upset. This view shows the stop which prevents accidental starting of the vertical hammer while the steel is in the vise (to right of vertical arm of foot lever)

rendering the service of the drill bit more effective. Among these advantages may be listed—

(1) Greater rapidity than is possible with hand sharpening. The drill men are not kept waiting for sharp steel.

(2) Labor economy: one smith can sharpen as much steel with a modern mechanical sharpener as several hand blacksmiths.

(3) Greater uniformity, resulting from die forming. All bits of the same shape and gauge are identical. The wings are of even length and the corners square and sharp, so that a good reaming effect is assured. Sets of mechanically forged steel always "follow" in the hole, decreasing the likelihood of stuck steel.

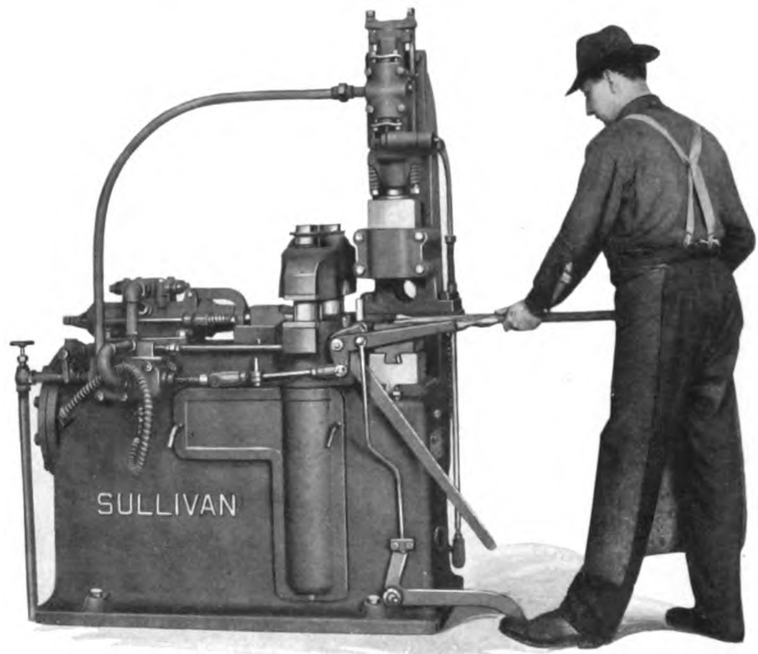
A danger encountered in mechanical sharpening is that in the effort to secure a large output, the quality of the steel may be injured by over heating or by improper manipulation, and, if possible, a sharpener should be selected in which this risk is not present.

ADVANTAGES OF HAMMERED BITS

It is conceded that bits properly made by a skillful blacksmith have no superior. This is because they are forged by gradual and repeated hammering, at moderate heats. Hammer work is the oldest and best method of refining iron and steel. It gives the metal finer, closer grain, greater strength and toughness, and greater resistance to wear and breakage.

THE SULLIVAN SHARPENER

The Sullivan Drill Sharpener, described in the following paragraphs, is a new machine, in which stress has been laid on this hammer action. In fact, in working out its design the effort has been to reproduce faithfully the good features of



Drawing out a bit in the Sullivan Sharpener. Note that the foot lever is depressed. The vise is idle, so the stop referred to in the cut on page 879 is raised, releasing the foot lever

hand sharpening, viz., to build a mechanical blacksmith.

This machine is illustrated above. It consists of three members: (1) a horizontal hammer for upsetting, (2) an air vise for gripping the steel during upsetting, and (3) a vertical hammer for swaging or drawing out the wings of the bit.

All operations are performed by air power at ordinary pressures, a one-inch pipe furnishing the supply. The sharpener is controlled by two levers, worked by the left hand and left foot of the operator. Steel clamping dies, set in the jaws of the vise, hold the steel while it is being upset by the steel dolly, and two steel die blocks serve respectively as anvil and swage under the vertical hammer.

HOW THE SHARPENER WORKS

As will be noted from the general views, page 879 and above, and the sectional view, page 881, the three operating members are mounted on a heavy frame, with the vertical hammer and anvil at the front, the vise just behind the anvil, in line with it, and the upsetting hammer just behind the vise. The vise consists of a stationary lower jaw and a heavy upper jaw or yoke, operated by two studs. These are raised or lowered by a link or toggle, driven by a crosshead that is moved by an air-operated, horizontal piston 12 inches in diameter. To upset a bit, the operator places the hot steel in the clamping dies, and depresses the hand lever (see the photograph on page 879). This first admits air to the rear side of the 12-inch piston, driving it forward, thrusting the toggle down, and so closing the vise with a force, due partly to the knuckle leverage of this toggle motion, estimated at more than 100,000 pounds. With the steel

thus held rigidly, further depression of the hand lever admits air to the upsetting hammer, which upsets the bit by rapid blows upon the dolly. When sufficiently upset, the operator raises the lever, first stopping the hammer, and then opening the vise by admitting air to the forward side of the piston.

DRAWING OUT THE WINGS

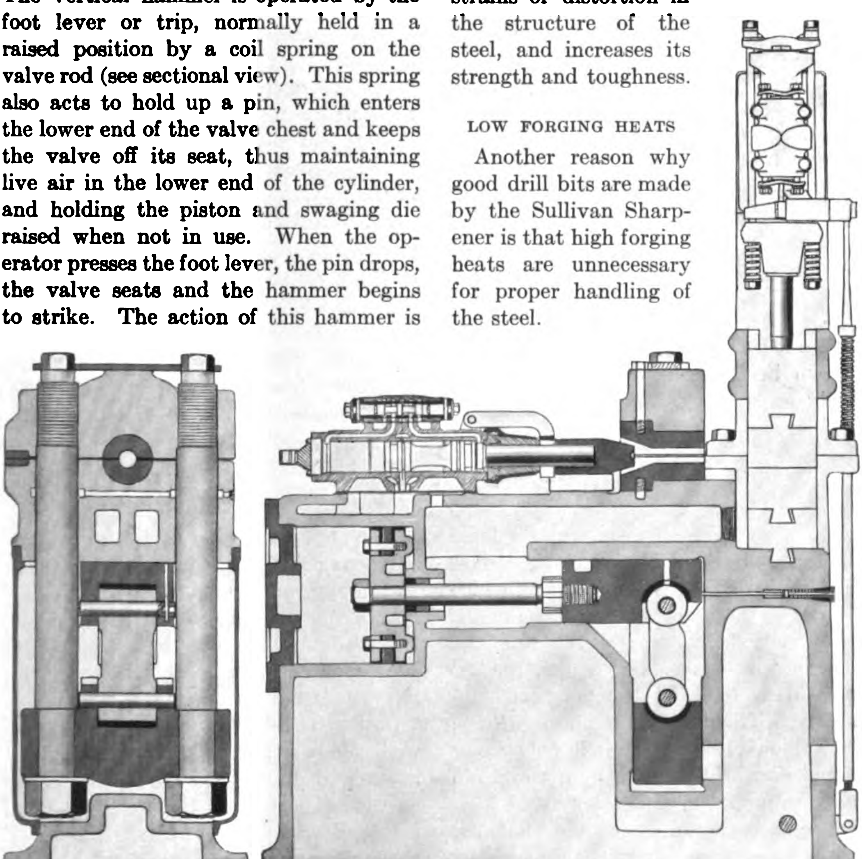
The wings are drawn out under the vertical hammer, which, like the horizontal hammer, consists of a modified Sullivan Rock Drill, with differential or independent air thrown valve motion. The vertical hammer is operated by the foot lever or trip, normally held in a raised position by a coil spring on the valve rod (see sectional view). This spring also acts to hold up a pin, which enters the lower end of the valve chest and keeps the valve off its seat, thus maintaining live air in the lower end of the cylinder, and holding the piston and swaging die raised when not in use. When the operator presses the foot lever, the pin drops, the valve seats and the hammer begins to strike. The action of this hammer is sensitive, so that heavy or light, slow or rapid blows may be delivered as desired.

HAMMER ACTION AND ALTERNATION

As stated above, the outstanding feature of the Sullivan Sharpener is its "all-hammer" action. Nearly as important is the fact that the processes of upsetting and drawing out are not completed one at a time, but are alternated. The steel is upset a little, then swaged a little, and thus gradually worked into its final shape and gauge. In making a new bit, the steel is under each hammer three or four times. This gradual treatment prevents strains or distortion in the structure of the steel, and increases its strength and toughness.

LOW FORGING HEATS

Another reason why good drill bits are made by the Sullivan Sharpener is that high forging heats are unnecessary for proper handling of the steel.



Sectional view of Sullivan Drill Sharpener, to show the details of the clamping cylinder, toggle and vise. In this position the vise is closed

The all-hammer process enables bits and shanks to be made up properly at moderate heats, ranging from 1500° to 1700° Fahrenheit. At such heats, there is no danger of burning the high carbon steels that are now in extensive use, so that drill users can secure to the largest extent the advantages of mechanical sharpening combined with the best steel that the experience of manufacturers has produced.

RAPIDITY

Low forging heat and gradual hammer working of the bit do not mean that making bits in the Sullivan Sharpener is slow, or that several heats are needed. On the contrary, the process is unusually rapid. New bits on blank stock are made in one heat and in one minute or less. Resharpening old bits requires a shorter time.

This high speed is due to (1) the convenient arrangement of the machine; the steel has to be moved only a few inches in alternating from one hammer to the other and back again; (2) the movement of the vise, impelled by its 12-inch air piston, is prompt and rapid, only a second or two being needed to close the vise firmly on the steel, or to open it so that the bit may be withdrawn; (3) changing dies and dollies; each gauge requires a separate upsetting dolly. The dollies are loose blocks of tempered steel, bored out at the blank end to receive the loose shank or rod. The floating piston strikes on the other end of this piston rod, which is upset so that it cannot be forced out of the cylinder. To change dollies, the loose rod is thrust back a few inches, the old dolly lifted out and the new one substituted. This requires a minute or less. The gripping dies are made in halves, the lower being held in place by a dowel pin and the upper by a screw stud. To change the square swaging die blocks, it is only necessary to drive out the keys by which their bases are held in place in the guide block and anvil.

SAFETY

The Sullivan Sharpener is well provided with safeguards against injury to the operator. Air cannot be admitted to the upsetting hammer until the vise has gripped the steel; nor can the vise release the steel until the hammer has stopped working. This prevents the hammer from striking the steel while the latter is not firmly gripped, and shooting it violently out, which might cause injury to the smith or his helper. Additional precautions are a coil spring on the valve rod, which holds the valve over the port leading to the upsetting hammer when the clamping cylinder is not in use; and a stop and lug attached to the vise yoke and valve rod respectively. This stop prevents the operator's lever from opening the port leading to the upsetting hammer as long as the vise remains open. When the vise is closed, the stop drops down out of the way.

An interlocking device prevents the operator from moving the foot lever to start the vertical hammer while the steel is in the clamping dies. This is shown in the cut on page 880. The vertical hammer may be positively locked, while changing dies, etc., by thrusting a steel pin through the guides and guide block. This pin is permanently attached to the machine.

ADAPTABILITY

The Sullivan Sharpener forms and sharpens drill bits of any shape and size, and in any range of gauges, on both solid and hollow steel. By the use of pin or "wet" dollies, the hole in hollow steel is kept open and a separate process for this purpose is not required. Shanks of any form can also be forged, including those with collars or lugs, as used in the modern hammer drills. These require upsetting as well as swaging. Shanking by hand is fussy work at best, and as hammer drill shanks require exact uniformity as to length, shape, and squareness of the striking end, mechanical sharpening lends

itself admirably to this work. The vertical hammer can be used by a clever blacksmith for a variety of outside work, such as coal cutter bits, bolts, stone dressing tools, etc., while the horizontal hammer has proved useful for many jobs in which upsetting is necessary. Mine car coupling pins are an example of this use.

The Sullivan Sharpener is compact, occupying a floor space of 5 x 2½ feet, and a height of six feet. On this account it is being successfully used in various underground mine blacksmith shops. The machine is substantial and intended to endure long and severe service. It weighs 4,000 pounds.

The owner of a Sullivan Drill Sharpener may well feel that this machine will make his investment in drills pay its highest returns in rapid, economical drilling, due to the fact that "Sullivan hammer sharpened bits cut faster and farther."

DEEP MINING WITH IRONCLAD COAL CUTTERS

By R. A. Lowry*

The use of mining machines as a substitute for undercutting coal with a hand pick or, in later days, as an alternative to "shooting off the solid," will be acknowledged by all readers as one of the most important elements making for success in the coal industry.

The compressed air pick machine, the chain breast machine, and now the continuous cutting chain type, electrically or air driven, have rendered mining more successful, in safety, in rapidity of production, and in economy. Another step in advance, that promises an increased factor of success, is the employment with the Sullivan "Ironclad" type of continuous coal cutter, of cutter bars of greater length than hitherto considered practical.

It used to be an accepted theory that coal of average height could not be shot successfully to the back of the cut, when this was more than one and one-third the height of the face, or, in the case of thick seams, when cut to a depth greater than the height of the face. A standard maximum length for chain machine cutter bars has been, for several years past, six and one-half feet.

About two years ago, Col. Edward O'Toole, General Superintendent of the United States Coal & Coke Co. at Gary, West Va., came to the conclusion that with clean coal, free of sulphur and other impurities that hinder shooting, strong roof and even bottom, such as are found at Gary, coal could be mined and shot successfully to considerably greater depths.

At his request the Sullivan Machinery Company made up Ironclad Coal Cutters with bars eight feet six inches long and then, as these proved successful, machines with bars ten feet four inches in length.

The performance of these machines at Gary was watched by the management with great interest. After a thorough test, the following results were evident: Comparing the ten-foot four-inch bar with the 6½-foot bar, the longer bar cut 64 per cent more coal in the same places, cost only about one third more for labor and power, required fewer repairs per ton, produced a larger percentage of lump coal, and required less powder per ton. Moreover, the development progress is materially increased by the long bar machines. An average advance of 160 feet was made with 6½-foot bars per month working single shift, while 250 feet is an average for the ten-foot four-inch bar during the same period.

USE AT CLINCHFIELD COAL CORPORATION

The accompanying photographs show the long cutter bar Ironclad in use at the mines of the Clinchfield Coal Corpor-

*841 Court St., Huntington, West Va.

Sullivan Ironclad with ten-foot bar, unloading from its self-propelling truck, Dante, Va.

ation, at Dante, Va., mining the "Upper Banner" and "Lower Banner" seams, in Virginia corellation.

The "Upper Banner" is a woody, friable coal with comparatively well pronounced faces and butts, averaging five feet in thickness. The top is sand rock and the bottom comparatively hard fire clay. The "Lower Banner" seam will average not over three feet six inches high, and is more blocky, with a slate top and fireclay bottom.

These mines had been equipped with machines of several makes; but Mr. Lee Long, the general superintendent, became convinced that his coal was adapted to deep mining. He gave the Sullivan Ironclad with ten-foot four-inch bar a thorough trial and was so pleased with the increase in over-all efficiency and economy shown that he has since replaced many of his older machines with these long bar Ironclads.

On page 884 the long bar Ironclad is shown being unloaded at a room face, under its own power. On page 886 the cutter bar is shown partly under the coal, sumping on a sumping bar at the left rib. In the lower picture on page 886, the machine is partly across the face, moving under its own power on its cutter chain from left to right. The ten-foot four-inch cutter bar is entirely under the coal.

Deep mining at Dante has won a decided and pleasing success from several points of view. The machine runners at the mines of the Clinchfield Coal & Land Corporation were formerly paid on the basis of a certain price per face foot of undercut, but with the installation of the long bar Ironclad, the machine runners were paid on the basis of a stated price per place, a difference in the rate being made for wide and narrow work. This resulted in an increase in the earning capacity of the runner and a decrease in the cutting cost.

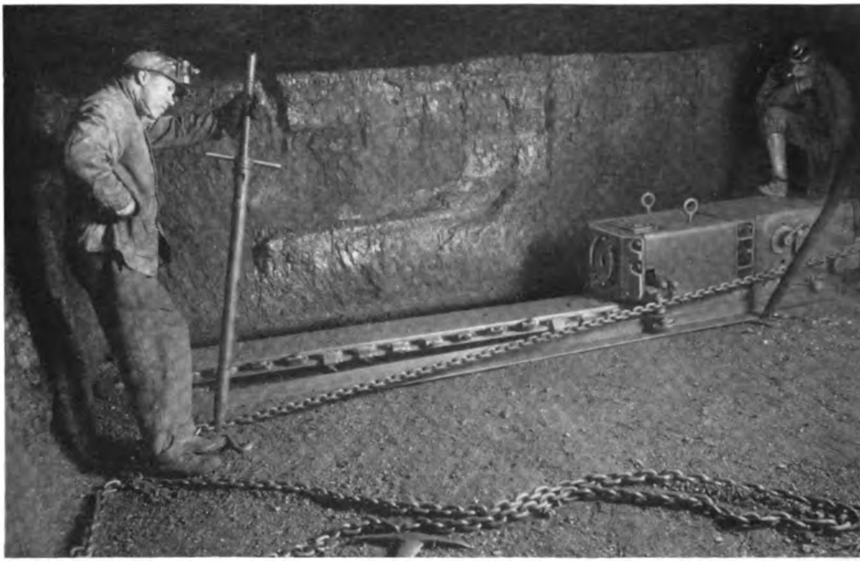
Actual performance in these mines shows that runners familiar with handling the long bar machine get approximately the same face footage per shift as with the six-foot bar machine. Each machine has an assigned territory of 22 to 25 rooms. As each long bar Ironclad pulls slightly more than twice as much coal per place as a six-foot bar machine of another make, it is necessary to cut each place only every other night. In the five-foot or 5½-foot coal, one cutting provides a loader with two full shifts' work, so that he may work at his greatest efficiency, with proper car supply. This efficiency is seldom attained in coal of any height with shorter cutter bars.

DRILLING AND SHOOTING

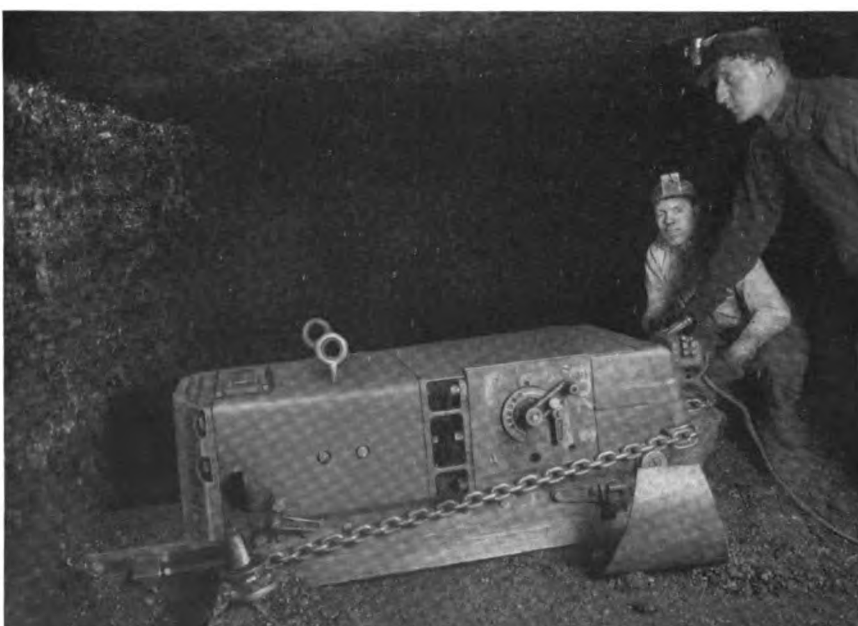
When the undercut is finished, the loader takes care that his kerf is thoroughly clean. This kerf is 5¾ inches high, the same height as that made by the short bar Ironclads. A seven-foot auger (see page 888) is then used to drill two rib holes (in rooms) six feet deep and about three feet from each rib. A center hole, seven feet deep, is also drilled, all three straight in from the face. Twenty-two inches of black powder are loaded at the back of the center hole, and 18 inches in each rib hole. The center is fired first as a pull or break down shot, and breaks clear to the heel of the cut. The rib shots break six to seven feet, so that when the coal has been loaded out after the first shooting, about three feet of coal is left standing on each rib, with the center clean. One light shot at each rib then turns the standing coal over and squares up the place.

An appreciable saving in powder and considerable increase in lump coal result. Page 888 shows a room at Dante, in five-foot coal, after firing the center shot. Note the large amount of lump and the relative absence of slack.

The "Lower Banner" seam has lent itself to deep mining with even better results, although it is only three feet six inches thick on an average. There is a pronounced cleavage plane about 18 inches from the bottom in this coal, and when



Sullivan Ironclad with long cutter bar, making the rib or sumping cut at the Clinchfield Mines, Dante, Va.



Sullivan Ironclad crossing the face. The ten-foot cutter bar is almost completely under the coal. The machine is moving from right to left, or toward the reader

undercut to a depth of ten feet, the lower part of the seam drops down over the kerf, thus enabling the loader to pull the remaining two feet of coal with very light charges of powder.

LONG BAR IRONCLAD DETAILS

The Ironclad machines, equipped with these 8½-foot and ten-foot four-inch cutter bars, differ from standard Ironclads, using 5½-foot or 6½-foot bars, in length of bar only. The motors, gearing, friction feed mechanism, etc., are identical. That the standard machines are employed for this more severe service, without change, with so slight an increase in power consumption, and without appreciable increase in wear and tear on the machine proper, while producing 66 per cent more coal, is an excellent guarantee of the margin of safety provided in their construction. These machines are fed under the coal and across the face of the room with a ⅝-inch chain, the feed gearing being protected by an adjustable friction, and they will cut either from right to left or left to right.

The ability of the machine to cut in either direction, with no change except the turning of the bit in the link, is very important in rib work, as well as in room work, where it may be desirable to have the tracks on the left hand side of the rooms in one part of the workings and in other parts on the right hand side, with props close to the face; and this is a distinctive feature of the Ironclad. The steel cutter bar is of rigid built-up construction, with closely gibbed guides for the chain.

DEEP MINING A SUCCESS

The conclusion reached from studying the results of several installations, particularly those of the United States Coal & Coke Company and the Clinchfield Coal Corporation, is that deep mining is a decided success with Ironclad machines, and, where consistent with the mining conditions, nature of coal, etc., should be recommended to reduce: (1) first cost of machine installation; (2) powder consumption; (3) cutting cost per ton. Moreover, where a predetermined tonnage is expected, it should reduce the territory under development, which is an important feature when there is taken into account the maintenance of roads, ventilation, and supply of timber.

Then again, it should increase the percentage of lump coal and give the loader a more definite or dependable quantity of coal down, increasing his efficiency, and thereby raising the efficiency of the entire plant; since this innovation goes right to the face and corrects the most frequent failing of "no coal for the loader," allowing him to come on and more especially to knock off at will.

Mr. Lee Long's original purchase of Sullivan ten-foot Ironclad machines, 10 in all, enabled him to displace seven shortwall and nine breast machines with 6-foot bars, or 16 machines in all, and to secure a larger footage from the 10 new machines than he had been able to secure from the 16 old ones with short bars.

HISTORY OF THE COMPANY

The Clinchfield Coal Corporation was incorporated in 1906 and loaded its first coal on a short railroad, which carried it eight miles to the Norfolk & Western at Fink, Virginia. This company holds at the present time about 300,000 acres in fee. This property has been tested very thoroughly with SULLIVAN diamond core drills, of which the company owns two, one type "N," with a capacity of 2,000 feet in depth and one, type "CN," with a capacity of 800 feet in depth. They have drilled a total of about 125 test borings with these machines. Estimates indicate that these properties contain half a billion tons in workable seams. Seven seams in all underlie their holdings and these range from 3½ feet to 15 feet in thickness.

On page 889 is shown a SULLIVAN "DP-33 Rotator," of which the Company

Above—Drilling blast holes in a coal face undercut to a depth of ten feet with a Sullivan Ironclad

Below—Result of a center shot in a room in the Clinchfield Mines at Dante, Va., after being undercut with a Sullivan Long Bar Ironclad

uses several for rock excavation. The machine is here shown pulling sand rock top and is operated by a SULLIVAN portable, motor driven, mine car type "WK-2" air compressor. An average day's work for the "Rotator" is about 150 feet of actual drilling. At the present time, these drills are being used on an outside haulage way, in which a 400-foot rock tunnel is being driven with them.

The company owns four SULLIVAN "WK-2" compressors as described above, which are hauled from place to place by mules or by the mine locomotives. These are complete outfits, with motor, driving the compressor through gearing, and receiver, all mounted on one truck.

This property is developed at three points; namely, Dante, Laurel, and Crane's Nest. Each operation has a modern steel tipple, of which the illustration on page 889 is an example. These tipples are equipped with Marcus screens and Roberts & Schaeffer conveyors. The capacity of these several plants is about 8,000 tons per day. The Laurel operation is the most recent and was begun in 1910.

At Dante there is a thoroughly modern power house 70 x 100 feet in size, built of reinforced concrete. This contains two 1000 "kw" Willis-Parsons steam turbines with one 300 "kw" motor generator set on the floor. Current is generated at 6,600 volts, 60 cycle, three phase and is then stepped down through sub-stations at the different mines to 220 volts direct current. Motor generator sets are employed to convert the alternating current, carried on the transmission line, into direct current at the sub-stations. The longest transmission line is 47,000 feet in length.

All equipment is up to date and in the best practice. Their various camps are electric lighted with 110 volt AC current in the mine buildings and in the miners' houses. The houses are equipped with running water and fire protection.

RAILROAD CONNECTIONS

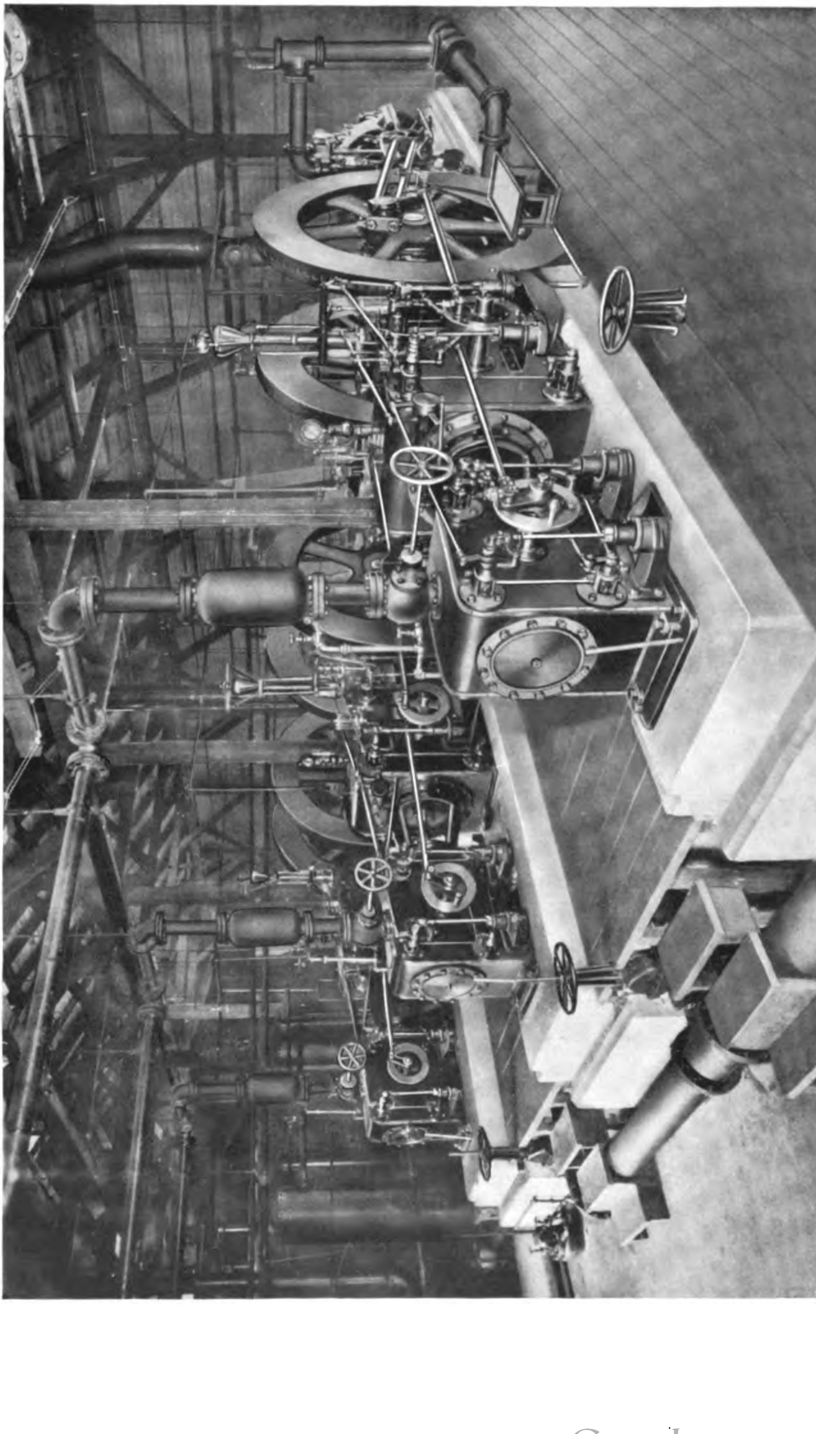
The Clinchfield Coal & Land Corporation's mines are served by the Carolina, Clinchfield & Ohio Railroad, which was built to develop this territory in the ex-

treme southwest corner of Virginia. The railroad was begun in 1905 and finished in February, 1914. The construction between Dante and Elkhorn City, Ky., which is the terminus of the line, is exceedingly heavy, being through the heart of the Cumberland Mountains. There are no less than 20 tunnels in 34 miles on this line, the longest being 7,900 feet, constituting the longest tunnel east of the Rockies and south of Mason and Dixon's Line. The average grade against southbound traffic on this line is between 0.5 and one per cent, while the maximum curvature is 10 degrees. The 7,900 foot tunnel is 1,800 feet above sea level.

The author acknowledges the courtesies of Mr. Lee Long, manager, in securing the information and photographs used in this article. [Editors note.—A portion of this article appeared in Coal Age, for April 10, 1915. It has been revised by the author for use in "MINE AND QUARRY."]

Sullivan Rotator taking down top in the Clinchfield Mine, Dante, Va.

Railroad tipple at one of the Clinchfield Coal Corporation's Mines



The three Sullivan Tandem Compound Corliss Two-Stage Air Compressors, two providing low pressure, and one high pressure air, in P. McGovern & Company's Tunnel Plant, Boston

THE DORCHESTER TUNNEL UNDER BOSTON HARBOR

By George E. Wolcott*

A tunnel-driving project of considerable importance is under way at the present time in Boston, Mass. This is an extension of the Subway system from the city proper to South Boston, under Fort Point Channel in Boston Harbor, a distance of approximately one mile under the water. The work is being done by P. McGovern & Company, contractors, who were the successful bidders, at about $2,500,000.00. The entering shaft is at a point near the South Station of the New York, New Haven & Hartford Railroad and the exit at West First Street and Harrison Avenue, South Boston.

The tunnel comprises two separate parallel tubes, each 24 feet in diameter. These are being driven by the caisson method from the South Boston end. One has advanced about 1700 feet in blue clay; while the other, which has encountered hardpan and coarse gravel, has been driven about 1000 feet. The rate of progress averages 15 feet per day in the clay, and 12 feet in the gravel. The work is of course continuous, the men working in eight-hour shifts.

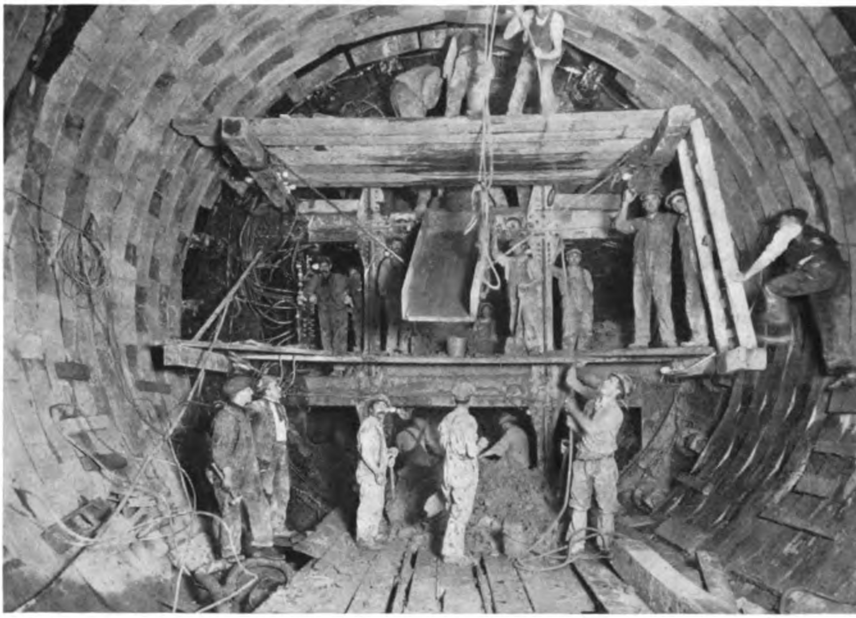
As the tunnels are being driven wholly in compressed air, the most vital and important part of the power plant consists of the air compressors. These are three in number, all being Class "WC" Sullivan Tandem Compound Corliss Air Compressors, with steam cylinders 16 and 28 inches, air cylinders 24 and 14½ inches in diameter, and a common stroke of 24 inches. Two of these machines are arranged for single stage compression, each having a displacement of 2,058 cubic feet free air per minute, at a normal speed of 120 r. p. m. and are suitable for a maximum pressure of 30 pounds to the square inch. The third machine, while of the same dimensions, compresses air in two stages against a maximum pressure of 120 pounds, and has a displacement of 1,500 cubic feet free air per minute at 120 r. p. m. A fact worthy of note in this connection and applying with particular force to a plant of this kind where both high and low pressure air is being used or required, is the ease with which this tandem type of Sullivan Air Compressor can be converted from compound or two-stage to single stage and vice versa without any change necessary other than the removal or attaching of the intercooler and rearrangement of inlet and discharge piping. These compressors also secure the highest possible steam economy, due to the fact that both high and low pressure steam cylinders are equipped with full Corliss valve gear, the point of cut-off being automatically varied to operate the compressor in the most economical manner by means of a special speed and pressure regulator, which is under the influence of the receiver pressure.

The boiler plant comprises four 150 horse power Hodge horizontal return tubular boilers. The steam pressure is 150 pounds and a large condenser of the jet type is used. Large aftercoolers are attached to the discharge pipes of both of the low pressure compressors, in order to reduce the temperature and humidity of the air in which the men have to work.

The splendid performance and economy already secured by the above plant as a whole is a source of much satisfaction to the owners, although as yet it is operating below its full capacity. It is anticipated that even better results will be secured when the full power of the equipment is required as the work progresses.

Up to the present no rock whatever has been encountered, nor is any anticipated, aside from boulders, as the formation or deposit under the greater part of Boston Harbor, as well as under the eastern section of the city proper, through which the existing subways have been driven, consists chiefly of blue clay with very little,

*185 Devonshire Street, Boston, Mass.



Heading in the Dorchester Tunnel, showing the shield, hydraulic apparatus, and lining forms

if any, rock. At greater depths, under the clay, soundings indicate a slate formation, but this is not likely to be reached in the driving of the present tunnel.

The air pressure required in the shield thus far has not exceeded 21 pounds to the square inch, although it is expected that it will be necessary to increase this to 25 or 27 pounds when maximum depth under the harbor is reached at approximately 60 feet below the surface of low tide water.

The two caissons or shields were furnished by the Boston Bridge Works and have cutting edges 26 feet in diameter. Each is forced ahead by 24 hydraulic jacks having a possible maximum water pressure of 100 tons behind each jack. They are thus capable of exerting a combined force of 2,400 tons if necessary to advance the caisson.

The progress thus far made in the driving of the tunnels has been somewhat more rapid than anticipated and it is expected that the work will be completed about October 1, 1916.

NEW ST. LOUIS ADDRESS

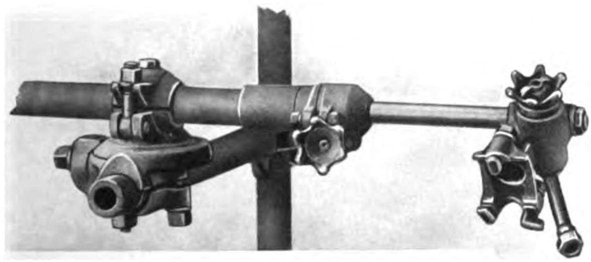
On November 1st, the St. Louis branch office of the Sullivan Machinery Company left its old quarters at 705 Olive Street for new and more commodious ones in Suite No. 2006, Railway Exchange Bldg. The company outgrew its old St. Louis offices some time ago and the change will enable it to handle its increasing business in the St. Louis field more promptly and satisfactorily.

SAFETY IN STONE QUARRYING

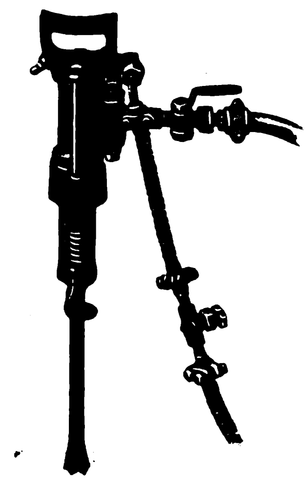
This is the title of Technical Paper No. 111, issued by the Bureau of Mines and written by Oliver Bowles, Quarry Technologist. It contains 48 pages, with careful analysis of the various causes of accidents in stone quarrying practice, with examples of proper prevention and recommendations to quarry owners. A few pages in the back of the bulletin are devoted to standard first aid instructions and methods.

NOW THE AIR FEED DRIFTER!

STAFF ARTICLE



Air Feed mounting with Rotator detached, ready for hand drilling



Labor economy, increased active drilling time, and greater drilling speed are some of the advantages gained by a new Sullivan drilling device which has made its appearance this year. To give this drilling rig its full name, the device about to be described is the Sullivan DP-33 Water Tube Rotator with Pneumatic Feed Mounting. As suggested, it consists, so far as the drilling tool proper is concerned, of a Sullivan Rotator or automatically rotating hammer drill, equipped with water tube attachment, and combining all the advantages of automatic steel rotation, spring steel retainer, automatic differential pressure lubricator, cushioned return stroke and dust-tight nose bushing characteristic of this machine, as described in the February, 1915, MINE AND QUARRY.

To drift with this Rotator, one removes the throttle valve, places the drill in a special saddle, tightens three clamp bolts and the "air feed drifter" is ready for work.

PNEUMATIC FEED MOUNTING

The saddle forms the outside end of a short arm or stand, which is attached at right angles to a piston rod 24 inches long. The rear end of this rod terminates in a piston which runs in a feed cylinder, the combination being similar in appearance to that employed in reverse feed stoping drills. The feed cylinder is clamped at any point desired in a hinged trunnion cradle which can be quickly loosened or tightened by means of one nut. The trunnion is of standard size, fitting a regular rock drill saddle, which is in turn mounted on a standard bar, column arm, or tripod.

The illustrations on pages 894 and 896 show two or three views of this drilling arrangement, and the cut on this page shows the details of the feed cylinder, piston, and arm and how the drill is attached and released.

Before describing the operation of the feeding arrangement it would be noted that the off-set arm which supports the

Sullivan Air Feed Water Drifter at work in a Michigan copper mine. The drill is above the arm and above the feed cylinder; this is the normal drilling position

drill contains an air inlet with swivel elbow and a throttle valve by means of which air is admitted to both the drill and the pneumatic feed. This throttle has several definite positions, in each of which a different effect is secured. The arm also contains an automatic inlet lubricator which delivers oil to all parts of the pneumatic feed cylinder and piston.

In one position of the throttle, the drill and steel are carried forward against the rock, for air is admitted only to the rear end of the piston. In a second position the hammer drill is started running. In two other successive positions of the throttle, the drill is brought up to full speed, and in still another position air is exhausted from the rear of the feed cylinder and admitted to the front side of the piston head, thus carrying the drill and steel back out of the hole and away from their work. By simply turning the throttle the operator may thus throw the drill forward or back with perfect ease and in a remarkably short time. The advantages of such a device over the crank and feed screw are too obvious to need much elaboration. With this forward and back air feed, drill steels can be changed in as little as 30 seconds. Readers should note there are no chuck bolts to loosen and retighten after the new steel has been inserted in the hole and in the chuck.

BALANCED FEED

In the air feed drifter, a balanced feed permits the operator to adjust the rate of advance of the drill to suit any conditions of rock or any angle of hole. A small handle will be noted on top of or within the throttle handwheel. This handle has two positions; in the first the full forward or backward feed occurs. In the second position a differential or balanced feed is provided, due to the fact that air is admitted to both sides of the feed piston at once. As the rear side of the piston occupies the full area and the forward side an area diminished by the cross section of the piston rod, the reader will see that a more gradual rate of forward feed is provided, thus retarding the advance of the drill steel when occasion requires. By a turn of the hand, the operator can throw this balanced feed into operation instantly, thus reducing the rate of progress if a slip, seam, or bug hole is encountered in the rock. This prevents the drill from burying itself, running out of line, or becoming stuck. This balanced feed is also valuable when drilling holes that point down.

MECHANICAL BRAKE

An additional means of feed regulation has been found desirable in practice. This is provided by means of a mechanical retarder or brake. This device is set just at the forward end of the feed cylinder and consists of a brake band encircling the piston rod and tightened or relaxed by means of a handwheel. By turning the handwheel, the feed piston rod can be locked in any desired position, so as to neutralize the feed altogether, or to establish any desired rate of feed, slower than that provided by the supplementary throttle valve. The advantages of this device in spotting drill holes on an inclined surface, in running through very soft ground, or in cutting out of a mud pocket can be readily appreciated. Should the drill steel show a tendency to stick, the operator, by setting the hand brake and throwing on the reverse feed can back his drill out of the difficulty with the hammer still running and the steel rotating, or, by simply turning the throttle valve, the drill may be made to alternately cut forward and backward, thus keeping the steel free.

Compare this simple turn of the wrist through an angle of not exceeding a quarter circle, with the cranking back and forth necessary with a feed screw mounting!

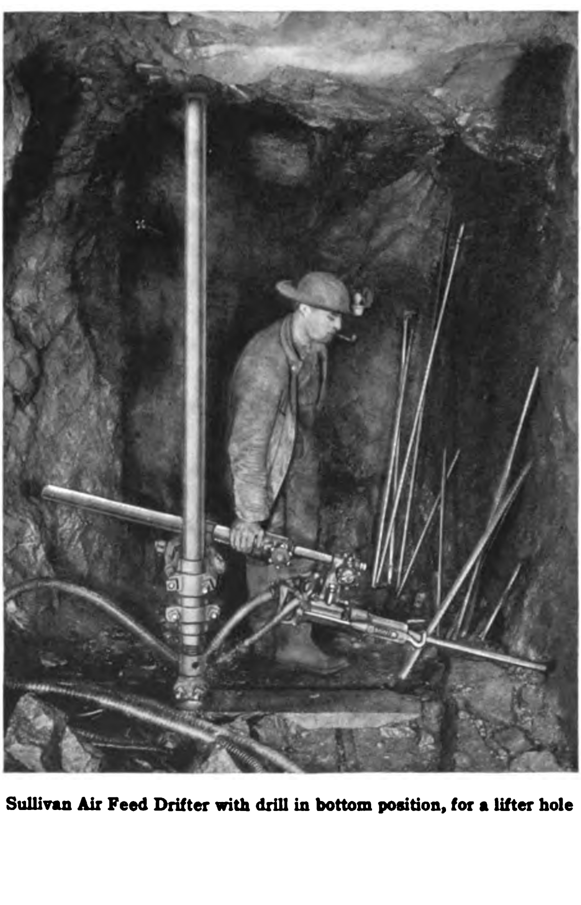
CHANGING STEEL

Steels of a uniform length are not necessary with this machine, nor is it

necessary to follow the range of length or "sets" required on feed screw drills. As the feed piston and feed cylinder are each two feet in length, a total range of nearly four feet can be secured in changing steel. If it is desired to use a six-foot No. 2 steel after running down a two-foot starter, the operator keeps on running his starter by pulling the feed cylinder forward in the cradle until only the rear end of the cylinder is clamped by it. He then slides the feed cylinder back as far as it will go and clamps it there, substitutes his six-foot "second" for the starter and, with the drill retracted until the feed piston is at the back end of the feed cylinder, he is ready to run down his long No. 2 as usual.

This range of feed is of great advantage, not only when odd lengths of steel are the only ones available, but when an irregular heading or stope is to be drilled. The manipulation described above, in such work will save frequent setting of the column. Perhaps the greatest economy of time and labor, due to this cause, however, occurs in slicing. In this work, the reach of the machine may be extended to take in a greater number of rounds without sacrificing any of the length of the last steel.

As already suggested, the running back of steel is accomplished almost instantaneously by means of reversing the air feed with the drill running or shut off, as desired. The spring steel retainer is then released and stays in the open position until the old steel is slid out and the new one inserted. Another aid to quick steel changing is the fact that the offset arm with the drill on it can be swung out of the way with one hand, by the operator, so that it is out of line with the hole. When the new steel is put in, it can be swung back in line and over the steel.



Sullivan Air Feed Drifter with drill in bottom position, for a lifter hole

SELF-ALIGNMENT OF DRILL AND STEEL

The fact that the drill is mounted on an arm offset from the line of the feed piston rod constitutes an important advantage of this new device. The slight swinging motion of the drill on the arm as the piston rod turns in its seat, permits the drill to remain in exact alignment with the steel at all times and to follow the steel laterally as this strikes slight inequalities in the rock, so that binding of

the bits due to rigidity between the steel and the drill and mounting is in large measure obviated.

As shown by the illustration, the ordinary method of drilling is with the drill above the feed piston rod. A novel and interesting adaptation is the fact that not only can holes be drilled with the drill below the feed piston rod for lifters, etc., but that, with the tool in the same position on the arm, two holes can be drilled in the face, 18 inches apart: one from the first position mentioned, and the second by simply loosening the hand brake and swinging the drill on its offset arm below the feed piston rod. When conditions permit, the drill runner can so plan his round as always to drill two holes from one setting of the saddle and arm, thereby cutting exactly in half the number of changes on the mounting as compared with the ordinary shell and feed screw machine.

VIBRATION

The air feed acts as a shock absorber or cushion, counteracting much of the jar due to drilling and thus reducing breakage of the machine itself due to vibration; and permitting the use of longer arms and lighter columns than is considered possible with the shell and feed screw type of mounting. The standard column for the air feed drifter is 2½ inches in diameter, and arms can be used on this column up to 36 inches in length, so that it is entirely possible and practicable to drill up a drift eight feet high by seven wide from one setting of the column.

LABOR ECONOMY

As there is no crank to operate, the runner can take up his position in the front of the machine on either side, where he can reach the throttle valve handle and the brake handle. After the feed has been adjusted and the hole spotted, there is nothing further for the operator to do, provided the rock is even, until the steel is run down and a new length is required.

As a matter of fact, operators of air feed drifters save considerable time by picking out their steels for the next change, clearing away broken rock, cutting fuse, or preparing for another set-up of the column, should this be necessary.

The effort has been made in designing this machine — and this effort has been largely realized — to increase the percentage of actual running time, that is, time in which the bit is actually hitting the rock, during a shift. That this has been accomplished must have been evident to the reader in noting the various economies of what is ordinarily classed as idle time; that is, during steel changes, freeing stuck steel, shifting the mounting, waiting for steel of proper length, pointing holes, etc., etc. In addition to the increased footage per shift, which this drilling rig secures, due to these causes, there is the increased footage resulting from the use of the fast-cutting self-rotating Sullivan "Rotator," employing the water jet discharged through hollow steel, to keep the cuttings cleared out of the hole and the rock at the face clean and free at all times.

AN ALL-AROUND ONE-MAN MACHINE

As previously mentioned, the drilling member of this device is a standard Sullivan "Water Tube Rotator." By loosening three clamp bolts the drill is released from the mounting and can be used for any hand drilling work that may be required, such as sinking, block holing, trimming up, etc. In this work the water attachment may be used or not as desired. If raising or stoping is required, the drill, on its pneumatic feed mounting, makes a practical stoping drill, upon being removed from the cradle which holds the feed cylinder. In this case, the rear end of the feed cylinder is placed against the ground, and the operator at once has an automatically rotating water jet stoper of improved design and great effectiveness.

The fact that this varied service can be secured from the DP-33 Rotator with the pneumatic feed mounting, and the effec-

tiveness of the machine with its water attachment in even heavy drifting work, makes it possible to claim for it the distinction of being the nearest approach to an all-around rock drilling machine ever developed. With it, holes for 1¼-inch powder may be drilled in drifting to a depth of eight feet, while in sinking, holes as deep as 12 feet may be put in.

It should further be noted that this rig is distinctly a one-man drilling outfit. The "Rotator" itself, with water attachment, weighs 39 pounds. The pneumatic feed mounting, including the offset arm and trunnion or cradle, weighs 65 pounds, so that either separately or together the drill and its mounting may be carried by one man into the most inaccessible portions of a mine and there assembled, set upon the column, and made ready for drilling.

For small mines and for leasers the pneumatic feed and drill combination is particularly attractive. A shaft may be sunk, cross-cuts run, and stopes opened all with the same tool.

"GRIME'S GRAVES"

Excavations at the prehistoric flint mines at Grime's Graves, near Thetford, Norfolk, England, have yielded many romantic "finds." Grime's Graves are 250 hollows in a pine plantation, which have been found to be the openings of shafts sunk by prehistoric Britons to obtain flint from the chalk.

One shaft, about 30 feet deep, has been cleared right out. It has been found to be 14 feet in diameter at the base, as compared with 22 feet at the mouth. From the base seven tunnels diverge, two of which are 30 feet long, though their height is only about 2½ feet.

The ancient miners used picks made from the antlers of the red deer. When these broke or became blunted they were thrown aside, and about fifty discarded specimens have been discovered.

Other discoveries include bones of various animals, quartzite hammerstones, and thousands of flint flakes and implements, including a fine axe 7½ inches in length. — *London Times.*

Sullivan Plug Drills at work, Sauk Rapids Granite Company

DEVELOPMENT OF THE SAUK RAPIDS GRANITE COMPANY

BY STANLEY G. HARWOOD, MECHANICAL ENGINEER*

The Sauk Rapids Granite Company is situated at Sauk Rapids, in Benton County, south central Minnesota, four miles from St. Cloud. This company, one of the youngest in the Minnesota granite district, was organized for the purpose of carrying on quarrying and finishing operations on a large scale, to the end that efficient handling of the quarry product, from monumental stock to crushed rock, might be attained.

Eight properties were purchased and welded into one system. There are four quarry groups, containing excellent granite of five different colors. These quarries are all connected with a spur of the Northern Pacific Railroad. Quarry No. 1 contains 48 acres in the form of a bluff 30 feet high. This is used to supply crushed rock, supplementing the waste from the other quarries. The company which formerly operated it has erected a crusher plant adjacent to the railroad.

Quarry No. 2, which was developed in conjunction with Quarry No. 1, by a former company, contains two deposits, one consisting of a good red and the other a dark gray granite, and was well opened when purchased by the Sauk Rapids Granite Company.

The group comprising quarries Nos. 3, 4, and 5 contains as fine a deposit of red and pink granite as can be found in the state. The group comprising quarries Nos. 6, 7, and 8 covers 40 acres and contains a fine grained light gray granite, suitable for high-grade monumental and building work.

In the town of Sauk Rapids the company purchased the property of the original Sauk Rapids Granite Company, consisting of a complete cutting and polishing plant. Additional land was acquired on which to build cutting sheds, storage yard craneways and machine shops for general service. This property adjoins the Northern Pacific main line and has access also to the Great Northern tracks. The purchase of the Monarch shed, with its adjoining property and excellent trackage facilities in St. Cloud, added a monument cutting plant to the system.

For the No. 1 crushed rock quarry a new and thoroughly up-to-date crushing plant was designed, including a No. 6 and No. 3 Gates Crusher and a Symons Disc Crusher. These machines are located in a pit below track level and receive the rock from the quarry as it is dumped from the cars. The crushed rock is carried to overhead screens and dropped into four bins which rest on a reinforced concrete table. These bins have a combined capacity of 400 cubic yards. Cars for shipping the material pass under the table and receive their load from the bin gates by gravity.

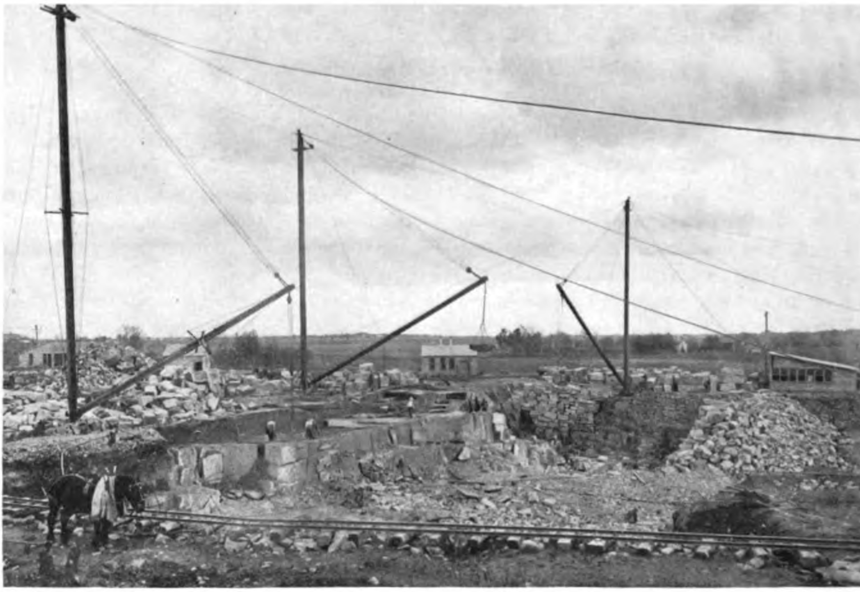
The old quarry, No. 2, now has three derricks, as shown in the picture on page 900. The two far derricks are operated by electricity and the one in the foreground by a steam plant.

HOIST AND COMPRESSOR

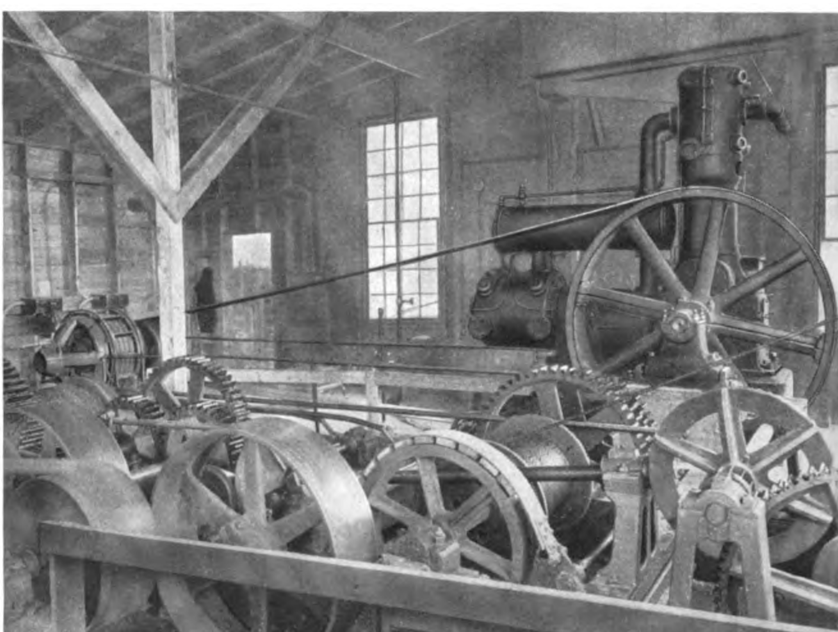
The interior of the power plant operating the middle derrick is shown in the lower picture on page 900. In the foreground is shown the New Albany hoist, having a lifting capacity of 15 tons with single rope. This hoist is of the belted type, the power being taken off by friction pulleys. It has three drums, main fall, boom fall, and swivel, and is furnished with power by a 25 h. p. General Electric, Form L induction motor.

Behind the hoist is seen the Sullivan Angle Compound air compressor and its 100 h. p. G. E., Form L induction motor. This compressor, under normal load, furnishes 628 cubic feet of free air per minute at 100 pounds pressure. This air is discharged into a receiver, just outside the

* 2644 Aldrich Ave., So., Minneapolis, Minn.



Sauk Rapids Granite Company, Quarry No. 2, Sauk Rapids, Minn.



Hoist and Sullivan Angle Compound Air Compressor at No. 2 Quarry

power house and thence is conducted to the quarry. Another line runs along the railroad track, supplying the paving cutters with air. A pipe connection between this plant and the one on the right equalizes the pressure of the system and renders it more flexible.

QUARRY DRILLING

In this quarry (No. 2) a channel about 60 feet deep and ten feet wide was first taken out. The plan of this channel on the quarry floor is T-shaped, so that a very large amount of stone was liberated on three sides at once. The channel cuts are made with a 3¼-inch reciprocating drill, mounted on a standard quarry bar. Cross bits are used, the holes being drilled about six inches apart on centers and the core or rock between the holes being broached out later with a broaching bar. For all other deep hole work the same type of 3¼-inch drill is used, but mounted on standard universal tripods.

These drills are the Sullivan class "FL-3 Hyspeed" type, which have a 28-inch feed on the shell instead of the customary two-foot run. The valve motion of this drill is such that a small super-valve, actuated by a tappet, operates the main spool valve. This combination gives the positive action of the old tappet type of drill, combined with the speed of the differential valve type. This drill can be short-stroked for starting holes, etc., as readily as the differential type. It is also economical of air, as live air is not required to throw the main valve.

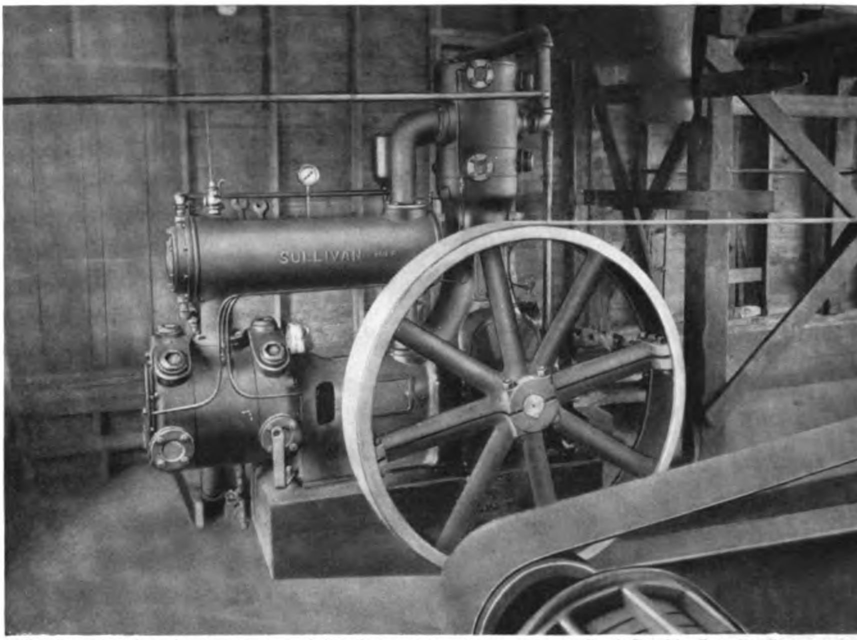
A large part of the quarrying is done with hammer drills. For shallow hole work the Sullivan "DP-33" Air Tube Rotators are used. Holes as deep as eight feet are drilled regularly, the drill being operated by one man. Hollow steel is used, so that a jet of air can pass through the steel and keep the hole free from cuttings. Six point "rose" bits were first used for this work, but experiments conducted by the superintendent, Mr. R. J. Colvin, demonstrated that a standard "bull" bit would hold the gauge better, drill nearly as fast, and require much less blacksmithing in this rock. The "Rotator" has a steel retainer which holds the steel in the drill, and is equipped with an automatic rotating device. Blocks of stone up to 15 tons in weight are taken out and then split to size by means of plugs and feathers. The plug drills used are the Sullivan "DF-3" type.

Quarry No. 3 Power Plant

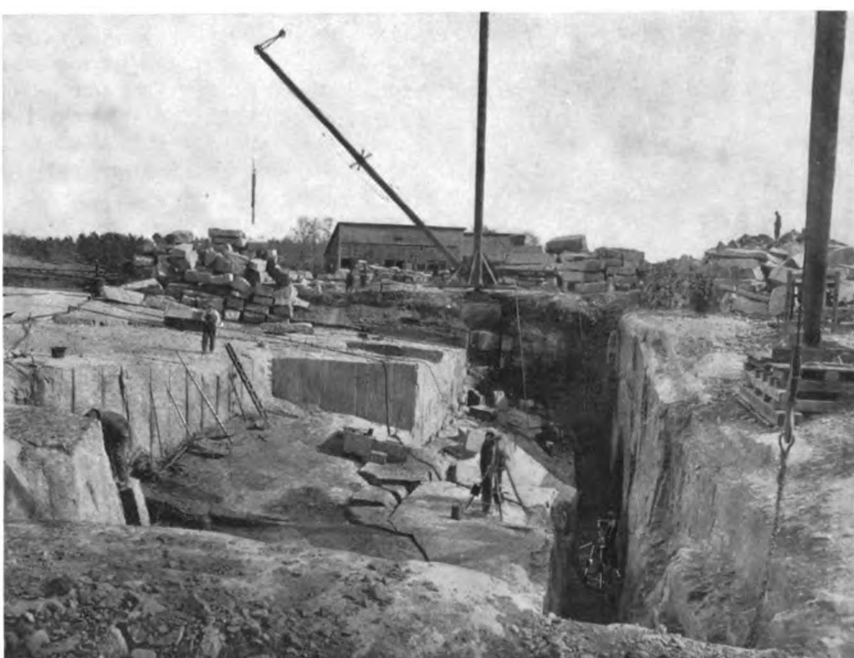
Quarry No. 3, shown in the lower picture on page 902, has one power plant and main derrick and an auxiliary hand power derrick. A 75 h. p. General Electric, Form L induction motor with counter shafting runs the plant. A 15-ton New Albany Hoist operates the power derrick. The upper cut on page 902 shows the Sullivan Angle Compound air compressor which furnishes air power for the drills at this opening. This machine has a capacity of 445 cubic feet of free air per minute at a pressure of 100 pounds per square inch. As can be seen in the picture of quarry No. 3, a large amount of development work has been done and a fine lot of monumental and building stock has already been taken out. A straight channel was first made and quarrying is being done on one side of this channel.

Further equipment of the Sauk Rapids Granite Company consists of an American Hoist and Derrick locomotive crane which greatly increases the flexibility of the handling system.

The equipment of the company is so complete that every cubic foot of quarried material may be used to advantage. The rock formation of its quarries is favorable to the removal of blocks of any shape and size that can be gotten out within the capacity (15 tons) of the derricks. Much of the stone is suitable for the finest monumental and building work. Paving blocks, curbing, etc., absorb the "seconds" and the crushing plant takes care of the remainder of the output.



Sullivan 445-foot Angle-Compound Air Compressor, Quarry No. 3, Sauk Rapids Granite Company


Quarry No. 3, Sauk Rapids Granite Company. Sullivan Tripod Drills at work

Situated in the Mississippi Valley, the Sauk Rapids Granite Company possesses an important advantage in freight rates over eastern quarries, giving it a large field in which its competitive position is very favorable.

Mr. George W. Bestor, president of the Sauk Rapids Granite Company, has been for many years prominently connected with the stone industry. Mr. C. C. Dragoo, vice president, has been active in the granite business at Sauk Rapids and Mr. E. R. Kelm, secretary, has been in the granite business at St. Cloud. Mr. R. J. Colvin, general supt., has had a wide experience in handling quarrying operations. The engineering work has been done by the writer.

CORE DRILLING AT THE HOLLINGER

By Albert M. Brown*

The rapid growth of the Northern Ontario gold mines has formed one of the sensational features of mining history in the past few years. One of the most interesting and successful of these properties is the Hollinger Gold Mines, Ltd., of Timmins, Ont., Canada. Starting operation in 1911 by milling 1,000 tons of ore, valued at $46,082.00, it has jumped ahead, until, during the year 1914, 208,936 tons of ore were milled, carrying a valuation of $2,688,354.00. Up to July 1, 1915, the total dividends paid by the company have amounted to $3,600,000.00.

The use of core drills has been of great assistance to the management in carrying on the rapid development of the property; and several ore bodies which had been missed by the ordinary methods of crosscutting have been subsequently located by diamond drilling.

The company carries on diamond drilling underground as a regular part of the routine work. Vein walls are prospected for branch veins by means of series of short horizontal holes, and extensions to veins which appear to have pinched out are sought for by similar means. Up to October 7, 1915, 21,344 feet of core drilling has been performed at this property.

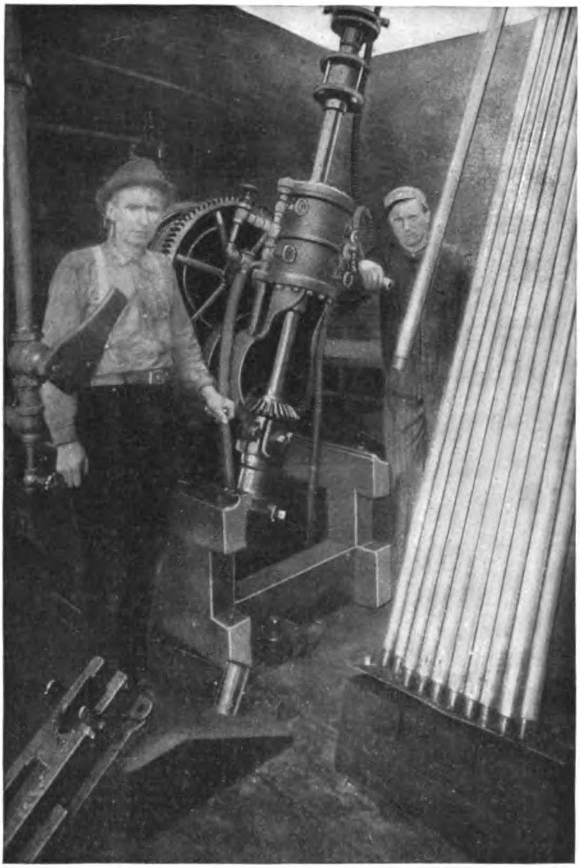
UNDERGROUND DRILLING

For assistance in determining the best method of development, four Sullivan diamond drills are employed. Two of these are class "S," having a capacity of 700 feet in depth and removing a $\frac{15}{16}$-inch core. A third is a class "E" machine, mounted on jack screws and employed in the narrow stopes for testing the various pockets of ore, which often occur on the main vein. The "E" drill takes out a core $\frac{15}{16}$ of an inch in diameter and will drill to a depth of 500 feet. Owing to its light weight and the fact that it may be dismantled if desired, it is easily pulled up into the high, narrow stopes and there set up.

The "S" drills are of small size and compact, especially adapted to work in drifts where space is limited. The drill rods and core barrels on all these machines are five feet long, permitting operation in cramped space without the necessity of cutting a station to operate the drill. The

Sullivan "E" Core Drill in a drift at the Hollinger Mine

*Lowell, Massachusetts.



Sullivan "B" Diamond Core Drill on the deep hole at the Hollinger Mine

pressed air from the company's central power plant. The photograph on this page shows the "B" drill set up for operation. This hole was started across the property at an angle of 60 degrees from horizontal. The course of this hole is indicated by the sketch on page 904A. It was bored to a depth, measured along the drill hole, of 2,000 feet, the vertical depth at this point being 1,425 feet. As indicated by the sketch, the angle of the hole flattened as its depth increased, so that at its final depth it was advancing at an angle of 45 degrees with the surface. The total variation in the 2,000 feet was therefore 15 degrees. This tendency of angle holes to rise is well known and was allowed for by the management.

The 2,000-foot hole was put down in a little less than three months. The average run, working two twelve-hour shifts per day, was 40 feet in 24 hours. The longest run in a single day was 55 feet. A tripod 50 feet in height was erected over the drill hole and the rods were hoisted in 30-foot sections, so as to save time in hoisting and lowering. Due to the use of this high tripod, it was also possible to substitute a 20-foot double tube core barrel for the ordinary 10-foot barrel. By the use of this special core barrel, which consists of two barrels in reality, one being an inner casing on ball bearings to protect the core from the wash water and the jar of drilling, from 85 to 90 per cent of the core was recovered from the hole.

underground machines are run by compressed air.

A photograph of the "E" drill in operation is shown on page 903.

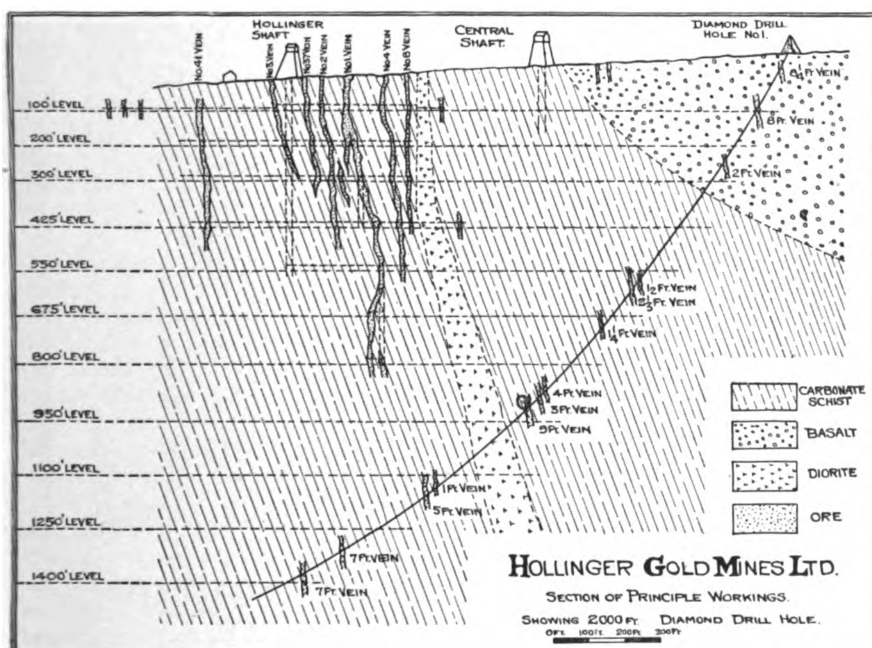
DEEP DRILLING FROM SURFACE

The Hollinger Company, in addition to its underground drilling, has undertaken to determine the extent of its veins at depth, and for this purpose during the past year employed a Sullivan class "B" diamond core drill, having a rated capacity of 3,200 feet. This drill removes a core $1\frac{3}{8}$ inches in diameter and uses 10-foot drill rods. It is operated by com-

Reference to the sketch below will indicate to the reader what this drilling showed the management; viz., that the veins being worked at the time ran to a depth of at least 1425 feet. In addition to this valuable information, several veins on the property, whose existence had not been suspected up to that time, were discovered. As the mine workings were then approaching a depth of 800 feet, the information thus secured has proved of great value to the management in further development.

The "B" diamond drill is equipped with a Sullivan single cylinder hydraulic feed, an important feature in deep drilling such as this, as it is very sensitive, permitting the operator to adjust the feed accurately to the formation of the ground, which in this vicinity is very broken and variable. The country rock, through which the drill passed in this work, was a soft schist, whereas the vein material was the gold bearing quartz, very hard in comparison. The hoisting gears are proportioned for a heavy line of rods, the drum making one revolution to 39 of the engine. For shallower holes and lighter loads, direct gearing in the ratio of one to 13 permits a more rapid hoisting speed. One revolution of the drum winds up about six feet of the rope.

The courtesy of Mr. P. A. Robbins, Manager, and Mr. A. R. Globe, Asst. Manager, is acknowledged with thanks in connection with securing the information used in this article. Mr. Nolan was the superintendent in charge of drilling work.



Information Revealed by a Diamond Drill Boring at the Hollinger Mine

SMOOTH, SOLID WALLS,

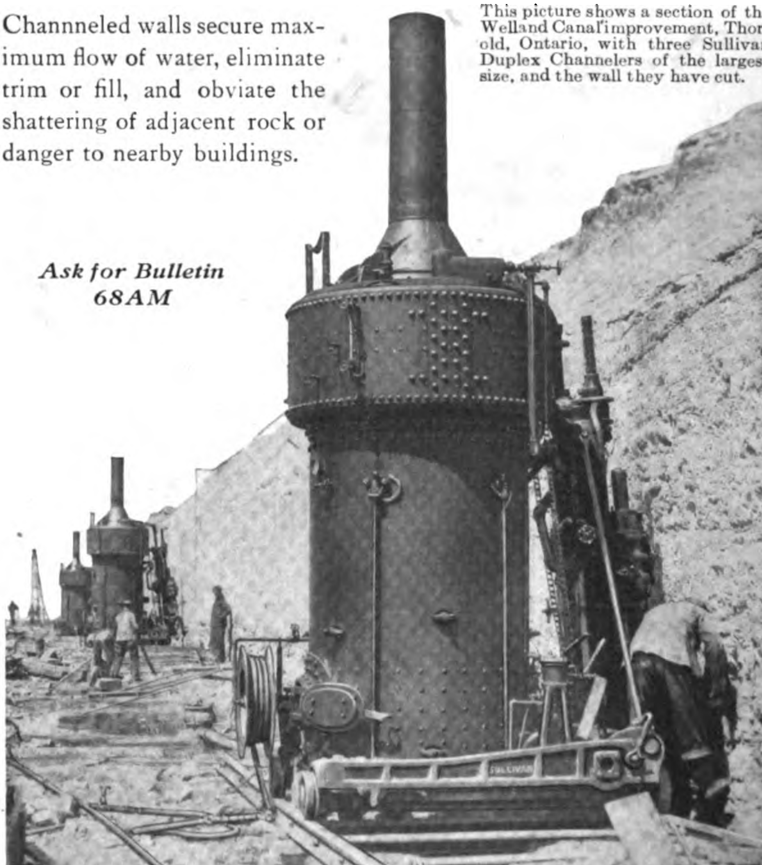
for your canal, lock or wheel pit can be cut from the solid rock, without blasting, most rapidly and cheaply, with

Sullivan Duplex Channelers

Channneled walls secure maximum flow of water, eliminate trim or fill, and obviate the shattering of adjacent rock or danger to nearby buildings.

This picture shows a section of the Welland Canal improvement, Thorold, Ontario, with three Sullivan Duplex Channelers of the largest size, and the wall they have cut.

Ask for Bulletin 68AM



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MINE AND QVARRY

REG. U. S. PAT. OFF.

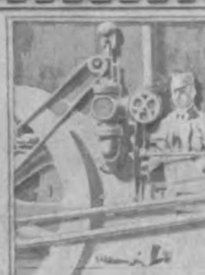
VOL. IX, No. 3 OCTOBER, 1916 WHOLE No. 31

Sullivan "DR6" Mounted Water Hammer Drill in a Michigan Iron Mine

TUNNEL PRACTICE AT ST. LOUIS

"PERMISSIBLE" COAL CUTTERS

TWIN ANGLE AIR COMPRESSORS



PVBLISHED BY THE SVLLIVAN MACHINERY CO. 122 S. MICHIGAN AVE., CHICAGO.

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MINE AND QVARRY

REG. U. S. PAT. OFF.

VOL. IX, No. 3. OCTOBER, 1916 WHOLE No. 31

A Quarterly Bulletin of News for Superintendents Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address

MINE AND QUARRY apologizes for the irregularity in its dates of publication. Many readers have inquired if their names and addresses had been overlooked. Such is not the case. Since June, the assistant editor has been serving with his battery in Texas, and in August, when he should have been devoting his days and nights to publication, the editor himself was with the civilian naval volunteers on board the U. S. S. "Louisiana." From this time forward, however, more and better editions of MINE AND QUARRY may be looked for. If you have comments or questions or changes of address to report, send us the card enclosed with this issue.

An engineering weekly recently contained a suggestion that manufacturers should publish a list of repair parts suitable for the machinery purchaser to carry in stock, to avoid shut-downs and delay in case of wear or accident. It is a common practice, among such builders as MINE AND QUARRY is acquainted with, to select such a stock of spares for their customers, usually at the latter's instance. This is especially important when the mine, quarry or contract is a long way from a warehouse. On another page will be found a timely article on "Keeping Track of Stock," which the editors hope may prove of assistance to its readers.

One advantage of such a plan is that the cards show promptly any unusual increase in the replacements of a given part or group of parts, so that the manager or superintendent can check up at once on undue wear, careless handling, etc.

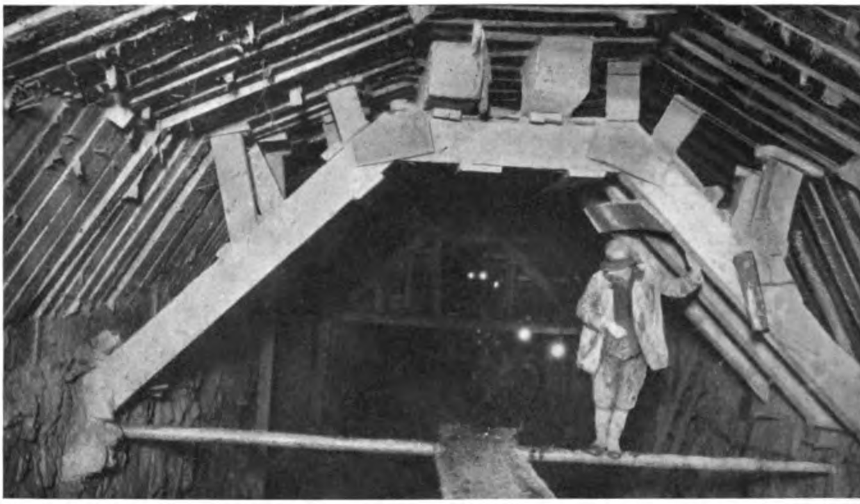
An index to the articles that have appeared in the issues of MINE AND QUARRY from October, 1912 to the present, inclusive, has been printed, and a copy will be sent to any of its readers upon request. Use the reply card enclosed. A limited number of the issues covered by this index is available in case readers desire to complete their files. Those still extant are the numbers for October 1912, January, April and August, 1913, January and April, 1914, February, 1915, January, 1916.

Mr. B. B. Brewster, local manager of Sullivan Machinery Company, Juneau, Alaska, has been appointed intermountain manager at Salt Lake City, in place of Mr. H. E. Moon, resigned. Walter F. O'Brien, associated with Mr. Brewster at Juneau, is appointed local manager for Alaska.

Mr. John F. Berteling has succeeded Mr. R. J. Raley as sales manager of Sullivan Machinery Company for the Lake Superior Iron and Copper district, with headquarters at Ishpeming, Mich.

A new bulletin, No. 75A, describes the Sullivan small, single-stage, belt-driven and motor-driven air compressors, classes "WG-3," "WK" and "WK-2," the last named being a portable design that has achieved great popularity for underground use in coal mines, etc.

Sullivan "DR-6" Mounted, Water Hammer Drills are described in a recent bulletin, No. 70-C. Copies of these bulletins may be obtained upon request to Mine and Quarry.



Work on the Mill Creek Sewer Tunnel, St. Louis. Timbering in Quicksand and Clay, Thos. Connor & Sons; Shows Extra Supports Required by Roof Pressure

Bottom Heading, Jumbo Timbers and Break-down, McMahon Construction Company's Section

TUNNEL CONSTRUCTION ON THE MILL CREEK SEWER

By E. J. Rossback *

The Mill Creek Valley Sewer at St. Louis, Missouri, was constructed to handle storm waters and intercepts the existing system. The purposes of, and elements governing the design of this work, were set forth in detail in a series of articles by Engineers Horner and Chivvis of the City of St. Louis, which appeared in the *Engineering Record* for October 3, 10, and 17, 1914.

A separate article on the concreting work was published in *Engineering News* for Oct. 12, 1916.

GENERAL FEATURES

The sewer has its beginning at Duncan and Vandeventer Streets and follows roughly an east and west line to its mouth in the Mississippi River at the foot of Rutger Street. Its total length is 20,040 lineal feet, the first 2000 feet west from the river being open cut and the remainder in tunnel. The tunnel has a section of horse-shoe shape, with pay lines 19x19½ feet. The cubic yardage per running foot is 11.75 and the estimated quantity of excavation in tunnel was 208,000 cubic yards.

DESCRIPTION OF SECTIONS

The Carter Construction Company of New York, the successful bidder on the entire job, divided the work into four sub-contracts, one open cut and three tunnel sections. The American Contracting Company of St. Louis was awarded the open cut sub-contract, from the river to Broadway, 2000 feet. The McMahon Construction Company, also of St. Louis, was given the next 5000 feet, to 18th Street: Brocklehurst and Potter Company, of New York, undertook the next 6500 feet to Virginia Avenue, and Thomas Connor & Sons had the sub-contract on the last 6540 feet to the end of the sewer at Duncan and Vandeventer streets.

* 32 Ave. des Champs Elysées, Paris, France.

The line of work intersected a railroad, manufacturing and residence district, just south of the main business arteries of St. Louis. This made the disposition of the material excavated somewhat of a problem and expense. Blasting, also, was attended with some restrictions.

THOMAS CONNOR & SONS

Thomas Connor & Sons found their section to contain 600 feet of soft ground, and 5940 feet of rock.

Their driving was handled through three working shafts proper. In addition, one connection, known as the Rock Springs connection, was started from a small shaft, and one manhole was sunk just across Vandeventer Avenue from the Duncan shaft.

This sub-contract involved approximately 100,000 cubic yards of excavation (running over the engineer's estimates), 25,000 cubic yards of concrete and 4000 cubic yards of brick masonry.

Work was begun on the shafts about November 15, 1914, the headings were turned about December 15, 1914, excavation was finished July 25, 1915 and the concrete lining was completed on December 20, 1915.

SHAFT CONSTRUCTION

The shaft at Theresa and Chouteau Streets is 112 feet deep and has inside dimensions of 12 x 16 feet. The "Tamm" shaft is 94 feet deep with the same inside dimensions. It was started through "made" ground and sheet steel piling was driven to the rock. The Duncan Avenue shaft was next sunk by the "open caisson" method. It has a diameter of 16½ feet and is 88 feet deep. The last 34 feet was curved from the vertical to the horizontal on a 25-foot 9-inch radius. The Rock Springs connection shaft was sunk somewhat later. It has an inside

How the Timbering was Carried up to the Face

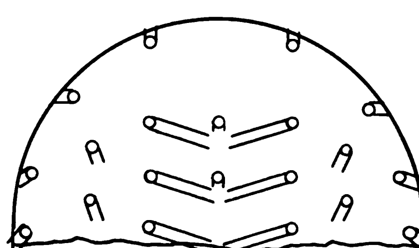
diameter of 10 feet and is 94 feet deep, and was also sunk by the "open caisson" method. Just before completion of the excavation a manhole six feet in diameter was sunk opposite the Duncan shaft to serve permanently as a means of access to the sewer. This is 88 feet deep. All shafts were sunk with self-rotating hammer drills. All were equipped with double compartments and single drum electric hoists, except the Rock Springs shaft and the manhole. The former was equipped with scale boxes and an air-operated hoisting engine of the usual construction type and the latter with buckets.

TUNNEL METHODS

The drive west from the Tamm shaft included 400 feet of quicksand, while that eastward involved 200 feet of soft clay. Both of these soft ground sections were handled without air pressure. Quicksand in the tunnel roof was supported by grouting and driving sheeting, a small pilot heading being driven in the center of the top of the tunnel section. Much difficulty attended this sheeting work because the quicksand rested on clay which contained limestone boulders. The bench consisted of more or less solid limestone. Great credit is due the contractor for the really ingenious manner in which this difficulty was overcome. Twelve by twelve timbers were placed skin to skin, 12-foot to 16-foot wall plates being employed. The spaces between the timbers were tightly calked with oakum. Some idea of the weight supported by these timbers due to the unequal ground pressure in this formation may be gained from the cut on page 906. This shows five-segment, 12 x 12 timbering with the wall plates carried on solid rock benches. Several segments began to give way and required temporary supports as shown. Part of the timbering west of the Tamm shaft was on rather a sharp curve and the accurate manner in which it was placed speaks well for the ability of the men in charge. The clay east of the Tamm shaft presented a somewhat less difficult task, although the boulders in the clay made the work troublesome. Three eight-hour shifts were worked most of the time while driving through the soft ground. One hundred feet of 21 x 9-foot heading, all in soft material, was driven from the Rock Springs shaft. This was timbered solid, and the bench, all in rock, removed from the Tamm shaft.

The rock encountered in this sub-contract was partly the characteristic Mississippi limestone prevalent about St. Louis, and partly a tough, siliceous, blocky and seamy limestone. The latter gave considerable trouble in the heading but drilled very well in the bench, due, no doubt, to its horizontal stratification.

A top heading seven feet high was driven, constituting about 30 per cent of the cross section, followed by a three-



Heading Round on Connor's Contract

foot bench and a nine-foot sub-bench. The benches were kept as close as possible to the heading to minimize the length of the wheel barrow "haul" from the heading. All mucking was done by hand labor and was the determining factor in the progress rate, the heading being shut down from time to time to allow the bench to catch up.

DRILLING THE HEADINGS

The heading was drilled by two drills mounted on two columns, one on either side. Each drill was operated by a runner and helper. The heading round consisted of from 18 to 24 holes, six to eight of which were center "V" cut holes (see sketch, page 908). Two relief holes in the center of the cut were drilled and shot simultaneously with the cut holes in the hard rock with excellent results. The depth to which the heading holes were drilled varied with the conditions, 8 to 12 feet being the usual range of the cut holes. The heading rounds pulled from six to nine feet, as a rule, although an advance of break of 11 feet was recorded. Six to seven hours were required on the average to drill the heading round. Two self-rotating hand drills drilled the bench and sub-bench, the holes being spaced about four feet back and four feet apart. This spacing was closer than necessary to break the bench, but was found advantageous in order to avoid sledging. One-inch 60 per cent forcite was employed in both heading and bench. All shots were fired electrically from a switch on the timber head frame.

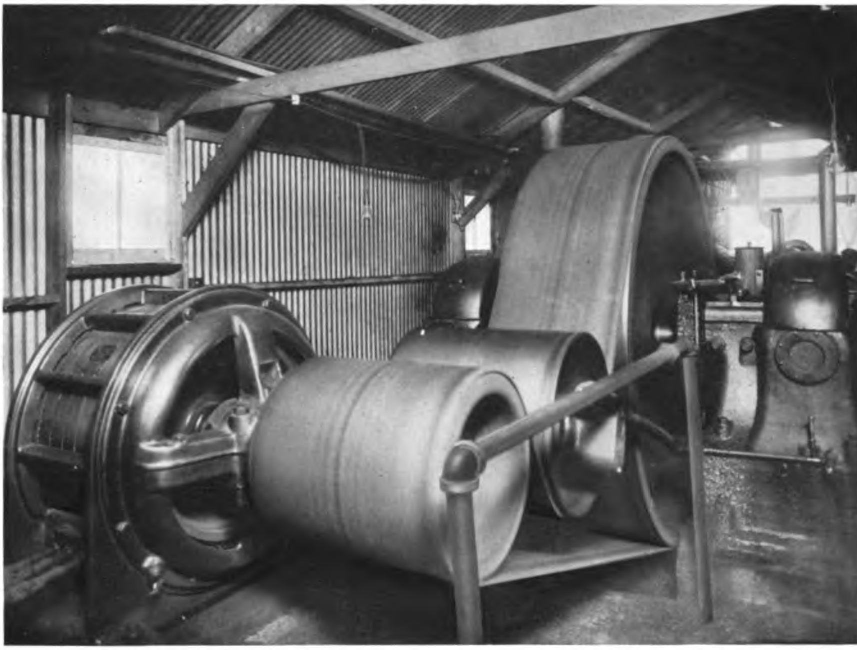
Sullivan Liteweight 2⅝-inch water drills were used in the headings at the beginning of the work but were later replaced in part with mounted water hammer drills, which proved superior in efficiency in the siliceous limestone. This was characterized by flint nodules and presented a really tough tunneling proposition. Six Sullivan "DR-6" type drills were used in this work with excellent results and to the complete satisfaction of the contractor, demonstrating marked superiority over a competing type of drill on this work.

The record for driving in rock (made in the section east of the Tamm shaft) was 116.2 feet of heading and bench in 13 ten-hour shifts, an average progress of a trifle less than nine feet per shift. The average daily progress in each heading and bench (two ten-hour shifts) was 11.5 feet. The longest drive in one direction from any shaft on the job was approximately 2000 feet (west of Theresa shaft). This required from January 1st to August 1st. Four hundred and two feet of completed tunnel section were driven east from the Tamm shaft in 56 ten-hour shifts.

AIR COMPRESSOR EQUIPMENT

All of the power used was derived from electric current, furnished at 220 volts,

12x12 Timbers Set " Skin to Skin," and Beginning of Brick Lining in Soft Ground Section



Sullivan WJ Compressor with Short Belt Motor Drive, Thos. Connor & Sons, Theresa No. 1 Shaft

Sullivan " WJ " Motor-driven Air Compressors, Armstrong Shaft, Brocklehurst and Potter, Contractors

three phase, 60 cycle by the Union Electric Company of St. Louis at a remarkably low rate, somewhat under one cent per kilowatt hour. The air plants consisted of two Class WJ Cross Compound belt-driven Sullivan air compressors, having a displacement of 1008 cubic feet per minute each, one located at Theresa and one at Tamm shaft. These machines did excellent work throughout the job, running 48 days continuously without a shut down on a number of occasions. They delivered air at pressures ranging from 90 to 120 pounds per square inch.

All of the muck was handled from the shafts by team, the hauls being short (not over one-half mile each way from any shaft). Most of the rock muck was crushed either in a plant near the Theresa shaft, consisting of one No. 5 gyratory crusher, or in the one near the Tamm shaft consisting of a No. 3 crusher. It was then sold, or stored for use as the aggregate for the concrete lining. The balance of the rock muck and the soft muck was dumped in a lot as filling.

PNEUMATIC LINING METHOD

The concrete lining was placed by the pneumatic method, with the exception of the invert, which was placed from cars. The success with which the pneumatic method was attended is shown by the following records. The best performance was the placing of 640 feet of lining in 127 hours of actual operation. In September, 1915, 1880 lineal feet of lining was placed in 46 10-hour shifts, 680 feet of which were placed in 13 shifts, or one week. In October, 1915, 1753 feet were lined in 46 shifts, which performance is noteworthy because of the fact that this stretch contained two sharp curves. It may be mentioned in passing that the tunnel section was very closely adhered to in the driving, the overbreak representing not over ¾ cubic yard per lineal foot of tunnel. Forty-foot standard steel forms were employed in the pneumatic concreting. The mixing apparatus was furnished by the Concrete Mixing and Placing Company.

The working day consisted of two 10-hour shifts except in the soft ground, as noted previously. An abundance of labor was available at all times, aiding to reduce the cost of the work. Powder was also considerably cheaper when the contracts were made than at this time. In the neighborhood of $40,000 was saved by the Connor Company alone, as against present prices.

The cars used were 1¾ cubic yards water measure. Pipe scaffolds were employed to support the runway from the heading to the end of the sub-bench.

BROCKLEHURST AND POTTER SECTION

The section of the Mill Creek sewer sublet to the Brocklehurst and Potter Company was the middle 6500 feet of the tunnel, and was characterized by almost ideal conditions. It was practically dry (all pumping being handled by 7 x 5 x 13 inch air-driven piston pumps at each shaft, operated only between shifts); it was possible to drive the sub-bench and bench 100 feet without losing a ledge, or stratification plane, to which to break, thus making mucking less arduous. No soft ground was encountered and the formation was the characteristic Mississippi limestone throughout.

The tunnel was driven from three shafts, one at Armstrong Street, another at Montrose, and the third at Ohio Street, six headings being operated simultaneously. Eighty thousand cubic yards of rock excavation were involved (3000 of which were shale). The concrete lining amounted to 25,000 cubic yards.

The Armstrong shaft, 15 x 19½ feet rough, 12 x 12½ feet inside the lining and 95 feet deep, was begun Oct. 29, 1914 and headings were turned on Dec. 17. The Montrose shaft has the same dimensions as the Armstrong and is 79 feet deep. This was sunk by the "open caisson"

Compressor House and Head Frame, Armstrong Shaft, Brocklehurst and Potter

three hand hammer drills for the benches. Five hand hammer drills were used in each of the other headings. The bench holes were spaced as on the sub-contract described above. The headings were also drilled in similar fashion, 18 to 24 holes being used. (See sketch on page 913.) A normal round consisted of 6 center, V-cut holes and two sets of eight holes each constituted the side rounds. The drilling time varied from four to six hours. A hammer cut was employed at times when the conditions of the heading were suitable.

The average completed tunnel excavation per working shift from the time the headings were turned was 4.4 lineal feet for the entire job, and from the time the cages were installed in the shafts, the average advance per shift was 5.1 feet. An advance, or break, of 8½ feet in one heading in one shift was recorded, although the average break in the headings was about five feet. Sixty per cent, one-inch forcite was used on this job also, for heading and bench. The best sustained records were made from the Montrose shaft. The west heading and benches were advanced 1472 feet in 298 shifts, a progress of 4.95 feet per shift. The east heading and benches were advanced 947 feet in 166 shifts, a progress of 5.77 feet per shift.

method. It was begun on Nov. 25, 1914, and the headings were turned Jan. 5, 1915. The last, or Ohio shaft, also a "drop" shaft (single compartment) 9 x 12½ feet rough and 6 x 9 feet lined, 77 feet deep, was begun on Feb. 2, 1915, and the headings were turned on March 8, 1915. The first two shafts each contained two compartments. The longest distance between shafts is 1500 feet.

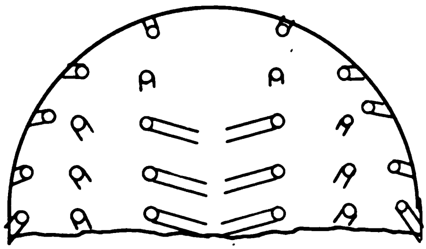
As on the Connor job, the top heading, bench and sub-bench system was employed, the heading being nine feet, the bench three feet, and sub-bench seven and one-half feet high. Hand mucking again proved the limiting factor as regards progress on this job, as on the one described above. The cars were of 1⅜ cubic yards capacity water measure.

DRIVING WITH HAND HAMMER DRILLS

Of the six headings, one was drilled with Sullivan Liteweight 2⅝-inch water drills, one with drills of a mounted water hammer type and the other four with self-rotating hand hammer drills of the Sullivan DP-33 type, held to the face by hand by two men. In each of the first two headings, the equipment consisted of four drills mounted on two columns and

CONCRETING WORK

The lining was placed, as in the case of the Connor job, by the pneumatic method. From July 19th to December 9, 1915, 1928 working placing hours, 163 forms, 40 feet long, were concreted. This work involved the handling of 18,000 cubic



Heading Round—Brocklehurst and Potter

yards of concrete and extended for a length of 6261 lineal feet. Eight different set-ups of the "gun" were required, the time for the set-ups being subtracted from total shift time to arrive at the above number of hours of placing. Eighty-nine cubic yards were placed per 10 hours of steady shooting and 73 cubic yards per 10-hour working shift, total time. The best work was done when 737 feet of tunnel was lined in 13 ten-hour shifts, making a record of 144 cubic yards placed per shift of total time. Four forms were used as against three on Connor's work.

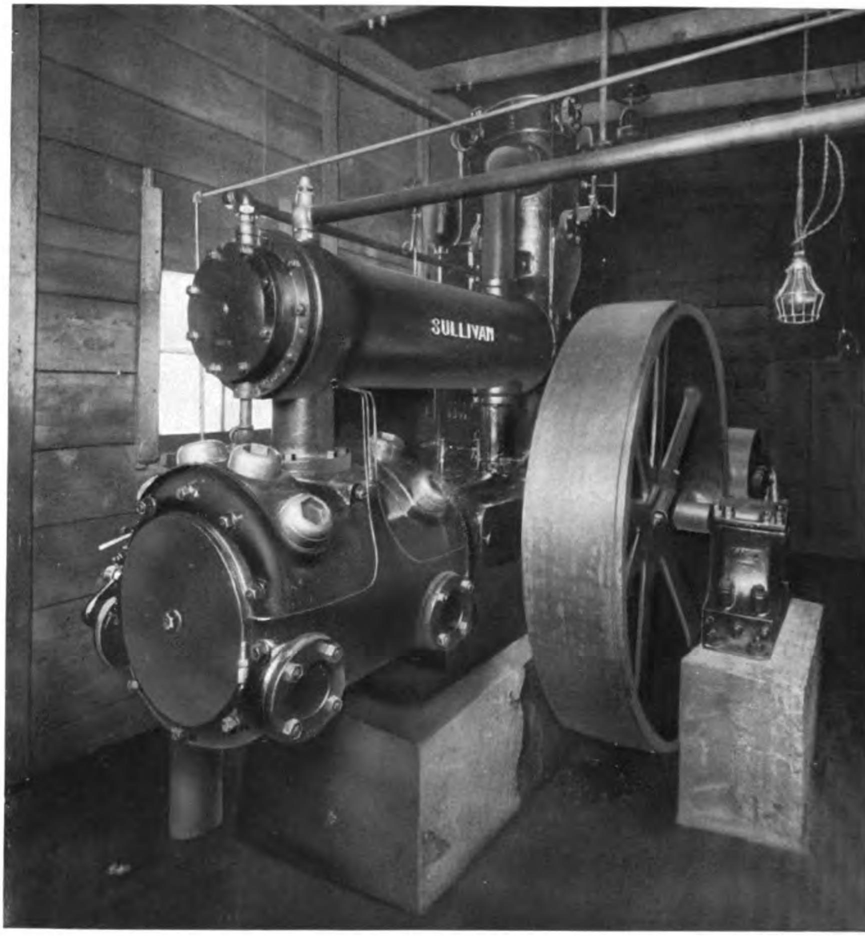
On the other sub-contracts, the concrete mixers were situated in the tunnel and the materials conducted to them by feed pipes dropped through well drill holes which had been bored for the purpose of checking the tunnel alignment. On the Brocklehurst and Potter job, the concrete was mixed on the surface and conducted through the drop pipe to the "gun." The power of the Sullivan Rotator Hammer Drill was demonstrated interestingly in this connection. One of these pipes, dropped through a 12-inch hole 57 feet deep, clogged, and the concrete set at a point 38 feet from the top.

After vain efforts to dislodge this mass of concrete, a 38-foot rod of one-inch round iron was made into a drill by welding on a ⅞-inch hexagon shank at one end and a cross bit at the other. This was lowered into the hole and put to work with a self-rotating hand drill. The first drill tried failed to make any progress; but when a Sullivan Rotator was substituted, the six-foot concrete plug was penetrated in two minutes. Two sticks of dynamite, 60 per cent, were then lowered to the center of the plug and shot with an electric exploder, shattering the concrete so that what remained was easily removed from the walls of the drop-pipe with a hand churn drill.

MOTOR TRUCKS FOR DISPOSAL

The muck was disposed of in similar fashion to that noted above. The shale was wasted in a dump. The solid rock was hauled by 5-ton motor trucks, to a crusher plant and storage pile. The haul was 1.3 miles each way, on the average. The trucks gave a splendid account of themselves, working 24 hours per day with the exception of Sundays. The contractor estimates that approximately 25 cents per yard was saved through the use of the trucks as against teams. This saving was in part due to the self-dumping feature of the trucks.

Portable Steel Concrete Forms in Place. Bracing for the Arch



Sullivan WJ3 Angle-compound Air Compressor, McMahon Construction Company

VENTILATION

The blower equipment for ventilating the tunnel may be of interest as it is typical of that used on the other sections. It consisted of two electrically driven No. 5-B blowers, rated at 2000 cubic feet per minute, one each at the Armstrong and Ohio shafts, and one No. 8B blower, rated at 6000 cubic feet, at the Montrose shaft. The air was carried to the face by collapsible canvas tubes hung in hoops at the side of the tunnel. Powder smoke gave some trouble early in the job, but this was soon overcome.

All plant equipment was electrically driven with the exception of the pumps. Each shaft was provided with an electric hoist, and two one-thousand-foot Class WJ Sullivan Cross Compound Air Compressors were installed at the Armstrong shaft, air being piped to the other two shafts. These are shown in the cut on

page 910. The air pressure was maintained at from 90 to 120 pounds gauge. These compressors also gave noteworthy satisfaction. Only one delay could be charged to these compressors and that was only of a few minutes' duration and was occasioned by the breaking of a belt splice. These machines also operated continuously, 24 hours per day, for long stretches of time without any sort of a shutdown.

All tunnel excavation was completed on July 15, 1915, concreting was begun on June 20th, and finished December 9, 1915.

MCMAHON CONSTRUCTION COMPANY

The James T. McMahon Construction Company executed the work just west of the open cut section for a distance of 5000 feet, 750 of which consisted of soft ground.

This work was handled through two working shafts, one at 6th Street and the other at 12th Street.

The sub-contract involved 65,000 cubic yards of excavation, 12,000 cubic yards of concrete lining and 3000 cubic yards of brick masonry. Work was begun on the 6th Street shaft on Nov. 20, 1914, and was completed in eleven days. The 12th Street shaft was begun on the 25th of November, 1914, and completed on Jan. 1, 1915. The heading west from 6th Street was turned about Dec. 1, 1914, and the two headings were turned, east and west, from the 12th Street shaft about Jan. 3, 1915. Both shafts are 12 x 16½ feet inside of the lining. The 6th Street shaft, 40 feet deep, was arranged for single compartment hoisting and the 12th Street shaft, 90 feet deep, had two compartments. Both shafts were sunk with Sullivan Class DP-33, self-rotating hand hammer drills.

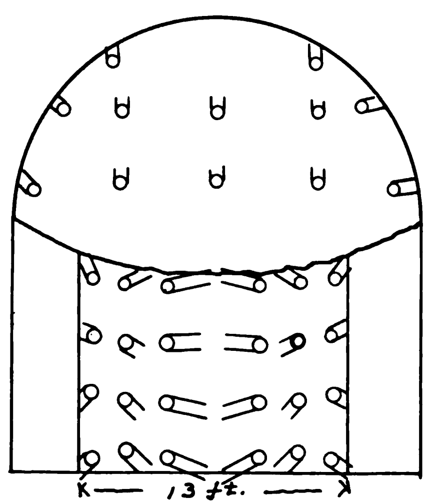
SOFT GROUND AND TIMBERING

The excavation in the four soft ground sections carried about 16 cubic yards per running foot and consisted of soft clay, containing many limestone boulders. It was impossible to drive sheeting through this formation. The section just west of 12th Street was very wet, a stream of water pouring down from the top pilot heading. The timbers were 12 x 12 inches, set either skin to skin or on 30-inch centers. The timbering in this section was exceptionally well done and presented a most pleasing appearance. (See cut on page 909.)

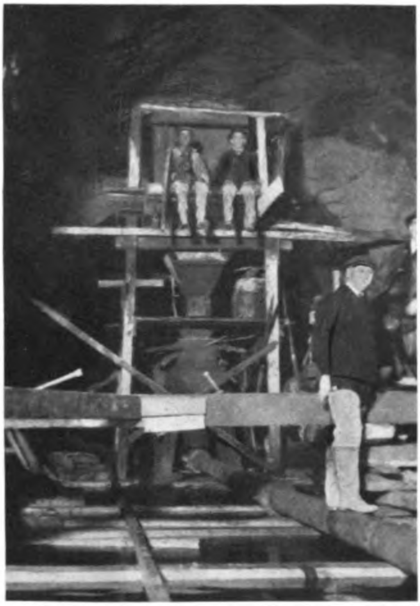
The rock on this sub-contract was the characteristic Mississippi limestone, with the exception of a section near the west end of the job, where flint nodules gave difficulty in drilling. A bottom heading 8 x 13 feet was used except in the soft ground section.

PISTON DRILLS IN THE HEADINGS

The heading was drilled by four Sullivan Liteweight 2⅝-inch water piston drills on two double screw columns. For the breakdowns and wings, Sullivan self-rotating hand hammer drills, Class "DP-33" were employed. The heading round (see sketch below) consisted of 22 to 24 holes, eight of which were center



Tunnel Rounds used by J. T. McMahon



Hopper at Foot of Well Drill Hole from Surface, and Pneumatic Concrete Mixer

Concrete Forms Bulkheaded, and Conveyor Pipe from Pneumatic Mixer

"V-cut" holes. Both cut and side round holes were drilled from seven to nine feet deep, giving an average break per shot of 4.5 feet. The heading was shot twice per shift and at times five times in two ten-hour shifts.

The average heading progress was about 18 feet each twenty-four hours. The breakdowns and wings were shot, as desired, to equalize the amount of muck that could be handled. Jumbo timbers were set up in the bottom heading and the breakdown shot onto them as shown on page 906.

The muck from the breakdown was then dropped into two-yard cars placed below the timbering. The bottom heading system was found to lend itself with special advantage to the handling of the work, whenever soft ground was encountered and it became necessary to drive up and start a pilot heading. Under these conditions, the practice was to drop back and work upon the wings and breakdown, thus maintaining a uniform output of muck from the shaft. The powder cost under this system was also pleasingly low. The powder consumption in the headings was four pounds per cubic yard, and in the breakdowns and wings one-half pound per cubic yard.

The Sullivan FF-12 water drills used in the headings gave a very satisfactory account of themselves and easily handled the drilling for two shots per ten-hour shift. In some instances the total time per shift, during which air was on the drills, was as low as one hour and thirty-seven minutes. When the flint nodules were encountered in the heading, a Sullivan mounted water hammer drill, Class DR-6, was used for a distance of about 150 feet at the western end of the job, and handled this difficult formation to excellent advantage. The self-rotating Sullivan DP-33 hand hammer drills did rapid and efficient work in shaft sinking, in the breakdown, wings and for drilling the boulders found in the clay.

The tunnel excavation was completed about December 1, 1915, although concreting had begun in certain sections about August 1st, the same year. The best week's driving record in the heading was 140 feet. A 500-foot section of heading, between 6th and 12th Streets, averaged 105 feet per week. Very little trimming was required and the over-break was unusually low; between 6th and 12th Streets being under the allowance of 6 inches.

SULLIVAN POWER PLANT

All of the power used on this job was electric current at 220 volts, 3 phase, 60 cycle, furnished by the Union Electric Company of St. Louis, as was the case on the other sub-contracts. All equipment, including the hoists, was driven by motors. The air plants consisted of one Sullivan WJ cross compound short belt-driven air compressor, located at the 12th Street shaft, and one 628-foot angle compound "WJ-3" Sullivan compressor at the 6th Street shaft. A second 628-foot "WJ-3," also short belt driven, was purchased later and used for a time at the 6th Street shaft and then moved to the 12th Street shaft, when concreting was first begun. These compressors gave the same excellent satisfaction as was recorded on the other sub-contracts. The air pressure varied from 100 pounds per square inch gauge to 125 pounds.

All muck was handled from the shafts by teams, the hauls from all the shafts to the crusher plants not exceeding one-half mile for the round trip. The concrete lining was placed by the pneumatic method with the exception of the invert, which was placed from cars. A record of 50 ¼-yard batches per hour of shooting time was recorded.

This job contained some rather wet sections and about fifteen hundred million foot gallons were pumped per month. A centrifugal pump was employed at 6th Street and piston pumps were in use at the 12th Street shaft.

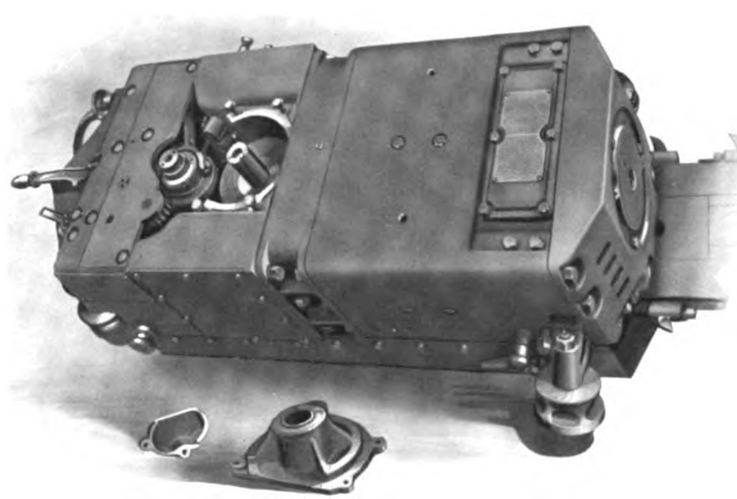
Completed and Lined Section, Mill Creek Tunnel

The cars used were 1¾-yard water measure. One-inch, 60 per cent dynamite and No. 6 caps were used. All blasting was done electrically, a switch being placed at the collar of the shaft.

It may be of passing interest to note that the two thousand feet of open cut just west from the Mississippi River contained 50,000 cubic yards of very close excavation and 11,000 cubic yards of concrete work. This work was handled by the American Contracting Company.

In concluding, the writer begs to thank the officials of the Carter Construction Company, of Messrs. Thomas Connor and Sons, of Brocklehurst and Potter, and of J. T. McMahon Construction Company, for courtesies received in the preparation of these accounts.

Never attach an air gauge to an air receiver by means of a siphon. On steam gauges, siphons protect the gauges from the heat of the steam. On air receivers the siphon is a source of danger, because the "U" or bend is apt to become clogged with moisture from the air, thus causing the gauge to register incorrectly.



Sullivan Explosion-proof Ironclad Coal Cutter, Showing Motor Casing and Approval Plate

PERMISSIBLE "IRONCLAD" COAL CUTTERS*

The increasing use of electricity in coal mines for haulage, pumping, cutting coal, etc., and the advances in efficiency and convenience which electrical apparatus has made for these purposes have caused a demand for motors that may be used in mines where gas is present and in which dust or gas explosions may be caused by an electric spark.

Manufacturers have given much study to this problem, and a large amount of work has also been done along this line by the United States Bureau of Mines in its efforts to provide for safer working conditions in the mines of the country.

In 1912 motors of various types were tested by the Bureau of Mines at the Pittsburgh Experiment Station, with a view to determining the requirements for permissibility as well as the suitability of the motor tested for the purpose in mind. These investigations were reported in Bureau of Mines Bulletin No. 46 by H. H. Clark. As a result of these preliminary tests no motors were found entitled to the Government approval as "explosion-proof."

A few months after the first investigation was concluded application was received by the Bureau of Mines to test mining machine motors of the Sullivan "Ironclad" type. As a result of the tests then made the Sullivan Machinery Co. has been granted approvals Nos. 100 and 101 on its 250-volt and 500-volt direct-current machines. The manufacturer is therefore entitled to place on each machine of this particular type and construction the combined government approval and caution plate illustrated on page 919.

To meet Government requirements it is not merely necessary that all outside connections be carefully insulated and that controller contacts, leads, etc., be inside the machine instead of outside.

*From Coal Age.

In the process of ventilation, air from the mine is drawn into the motor casing by a fan, so that a circulation of cooling air is kept up about the motor. If this air contains dust or gas in an explosive mixture, it may be readily ignited by a spark from the motor, within the casing, and unless adequate protective devices are furnished the flame may be carried outside the machine into the mine and a dangerous general explosion ensue.

In the tests made in the experimental gallery of the Pittsburgh Experiment Station, the motor casing of the "Iron-clad" machine was filled with and surrounded by the most explosive mixture obtainable of Pittsburgh natural gas and air. Other tests were made with varying amounts of gas in the explosive mixture and with coal dust sifted into the protective devices or within the motor casing. The motor was run at its rated speed in these mixtures and the air and gas in the casing ignited by means of a spark plug. The point of ignition giving the greatest pressure in the casing was also determined by test, and trials were made by igniting the mixture while under that pressure. In the course of these trials the motor and rheostat were tested 60 times, the cable reel 25 times and the fuse in the controller 15 times.

As a result of these tests no punctures of the motor casing or protective devices or of the cable reel were observed; that is, no flames from the internal ignition escaped to the outside air. A maximum pressure of 126 pounds per square inch was obtained in the rheostat chamber, 74.6 pounds per square inch in the motor casing, and 35 pounds per square inch in the slip-ring compartment of the cable reel. The fuse tests were made by connecting the fuse across the busbar of a 200-kw. 225-volt direct-current generator in series with a resistance equivalent to a circuit of No. 0000 B. & S. gage wire 530 feet in length (one way). The fuse opened the circuit promptly, with practically no noise and absolutely no evidence of sparks or flames upon the breaking of contact.

The test as a whole proved that the protection of the motor, starting rheostat, and cable reel was adequate at the time of testing. Upon the requirement of the bureau, a factor of safety was secured by changing the construction so as to reduce the maximum pressure from 126 pounds per square inch to less than 50 pounds in any part.

The summary of the tests is given in the table herewith.

Inspection of the mechanism of the machine indicated that its construction conformed to all of the published requirements of the bureau.

Approval Plate for Sullivan Permissible Coal Cutter

TESTS OF MOTOR AND STARTING RHEOSTAT

Number of Tests	Percentage of Gas or Dust	Cover Condition	Puncture*	External Flames	Dangerous After-burning†
13	8.6 gas	Seated	None	None	None
13	8.6 gas	Raised	None	None	None
10	8.6 dust	Raised	None	None	None
4	8.6 dust	Raised	None	None	None
10	7.0 dust	Raised	None	None	None
10	7.0 dust	Raised	None	None	None

TESTS OF CABLE REEL

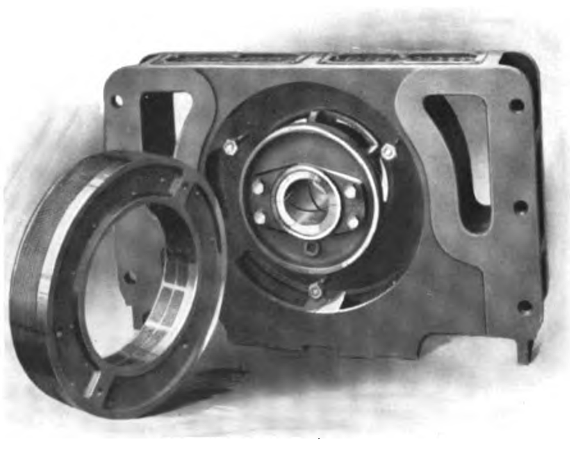
1	8.6 gas	....	None	None	None
9	8.6 dust	....	None	None	None
5	7.0 dust	....	None	None	None
10	7.0 dust	....	None	None	None

*The term puncture means the ignition of gaseous mixtures surrounding a motor casing by flames discharged from it. †The term afterburning is applied to the combustion, immediately after an explosion within an explosion-proof casing, of a gaseous mixture that was not within the casing at the time of the explosion, but was drawn in subsequently while the products of the explosion were cooling.

MECHANICAL ARRANGEMENTS

The motors used on the machines tested were, as stated, of two voltages—250 and 500. They were built especially for service on Sullivan "Ironclads" by the General Electric Co., and are of the CY-24-B pattern, compound wound and designed to deliver 30 h.p. at 1130 r.p.m. for one hour without exceeding a temperature rise of 75° C.

The motor is situated in the front half of the armor-plate body or casing of the machine, while the gears, friction, and other mechanical parts are housed in a rear compartment, as are also the rheostat and controller. The motor-casing protective devices are of the plate type, consisting of a large number of flat rings or thin plates, spaced close together. These rings form a collar made to fit closely the openings, one at each end of the casing, which surround the armature shaft bearings. The air or flame, in case of internal ignition, is forced to travel in a circuitous course through the baffle plates in order to escape to the air of the mine. In the journey it is cooled to such a low temperature and reduced to such a low pressure that the heat necessary to produce an explosion in gas outside of the machine is removed. The plates are protected by strong non-corrosive metallic gratings, or in newer designs by downward-looking openings on the corners of the casing. The only unprotected opening in the casing is one over the commutator, which is normally closed by a solid cover, tightly bolted to the motor frame.



Protective Device for Sullivan Explosion-proof Motor, Gear End

STARTING RHEOSTAT AND FUSE

The casing of the starting rheostat is made part of the machine frame. The controller plate is mounted on one side of the machine and the resistances on the other. They are, however, in the same box, and all leads between them are completely enclosed and protected. There is

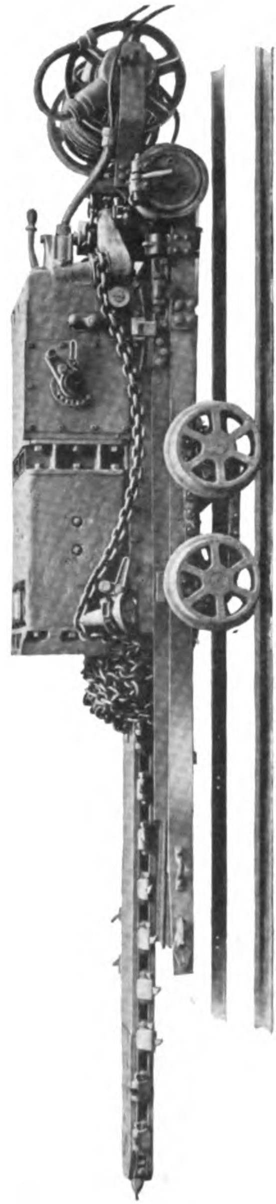
a cover plate over the resistances and one over the controller. Both cover plates are made with broad flanges and are fastened to the machine frame with stud bolts. The electrical connection with the trailing cable passes through the casing of the rheostat in the form of studs insulated with fiber washers and bushings.

There is mounted in the shaft of the controller a totally enclosed refillable fuse, having practically the dimensions specified for 250-volt 100-ampere fuses by the National Electric Code. The fuse is so placed that it is accessible from outside the machine without removing any covers, but the controller handle must be in the "off" position before the fuse can be removed, while fuse removal locks the controller handle in the "off" position.

The cable that connects the cable reel to the power supply is permanently connected to slip rings which are enclosed in an explosion-proof casing. The cable that connects the cable reel to the motor is provided with a plug which connects with the slip-ring brushes in such a manner that air cannot get outside the casing if the plug should be withdrawn while the current is flowing.

The trailing cable is clamped to the frame of the machine by an insulated clamp which sustains the stresses that might otherwise come on the insulated binding posts, by means of which electrical connection is made to the interior of the controller casing. These binding posts are specially designed to prevent the working loose of stranded conductors and are protected by a metallic shield.

Where the trailing cable enters the machine frame and also where it is attached to the cable-reel plug, the cable is protected by a flexible steel armor that bends easily to a minimum radius beyond which it will not go. This armor is designed to prevent the excessive wear that usually occurs where cables of this sort enter metallic frames.



Sullivan Permissible (Explosion-proof) Coal Cutter on its Power Truck

All wires are enclosed in explosion-proof casings from the point where the connection to the trailing cable enters the casing of the starting rheostat.

All bolt holes are bottomed or stud bolts are used, so that the omission of a bolt does not leave an opening through the explosion-proof casing.

The Sullivan Machinery Company has embodied the explosion-proof features of design in its standard "Ironclad" machines; and when ordered, the "permissible" machines may be obtained from the factory complete with the approval plate of the Bureau of Mines. All other machines of the "Ironclad" room-and-pillar type are shipped without the protective devices and without the approval plate. In other respects the machines are identical. Should gas make its appearance in a mine where these machines are installed at some later date, or should the machines be moved from a non-gaseous mine to one where danger of explosion exists, the owner may convert them into explosion-proof machines and affix the Government approval plate by purchasing and attaching the protective devices in the field, and by observing the cautions prescribed by the Bureau of Mines.

Users of continuous-cutting room-and-pillar machines therefore now have available to them in the new "Ironclad" a coal cutter either already made to conform to the safety standards of the Bureau of Mines, with all that this implies, or which can be made to so conform by minor changes made to the machine without removing it from the mine.

In conclusion it is well to repeat the advice as to supplementary electric equipment made by Mr. Clark in his report, in which he points out that it is of little use to provide safe coal-cutting equipment "if within the limits made dangerous by the presence of gas there are used in connection with the electrical equipment uninsulated wires or wires not installed upon suitable insulators and in a first-class manner. The protection of the electrical system in gaseous places must be made consistently complete."

BOULDER BREAKING AT A PLACER MINE

By W. R. Austin *

On Ruby Creek, eighteen miles from Atlin, British Columbia, is situated the pit of the Placer Gold Mines Company. At this property an interesting use has been made of Sullivan hand feed hammer drills, which may be interesting and of assistance to other placer operators in British Columbia, Alaska, and elsewhere. On Ruby Creek and most other placer properties the gold is found in the black sand on top of the bed rock. This sand is covered with sand, gravel, and large boulders mixed together to a depth of many feet and must, of course, be removed before the gold-bearing sand can be reached.

Many of these boulders are so large that they cannot be carried off by the monitors and must be broken up in some manner. In this work, the Sullivan hammer drills have accomplished great savings in labor, time, and powder. Prior to the installation of the two Sullivan DA-19, 40-pound hammer drills, early in 1914, all of these boulders were bulldozed: that is, sticks of dynamite were laid on top of them and the resulting explosion broke them up into sizes that could be washed away by the monitors. The amount of work of this sort to be done at this property is very large. In the 1914 season, which ran from about April 1st to the middle of October, 23,832 boulders were blasted. In getting rid of a good-sized boulder by the bulldozing method, seven or eight sticks of powder are necessary, so that the bill for powder ran into considerable money in the course of the season. The cost of powder for breaking boulders in 1913 averaged 36

*Hutton Building, Spokane, Wash.

cents per boulder, which, based on the same quantity as for 1914, would bring the cost of this item alone up to $8,579.50.

In order to reduce this expense, Mr. T. M. Daulton, manager of the property, installed a Sullivan 8 x 8 in. class "WG-3" belt-driven air compressor, and the two hammer drills referred to above. In spite of the fact that for various reasons it was not possible to use the machines over any extended part of the season, about 2,000 boulders were block-holed with the drill, creating a saving, figured by the management, of $1,200.00, for the season. As the cost of the entire plant, including the compressors, drills, steel, freight, and installation cost amounted to $1,250.00, it can be seen easily that the investment was a profitable one. Block-holing reduces the amount of powder required for breaking boulders, from seven to eight sticks per boulder, to one, and as dynamite is very expensive in that part of the country the reduction in the powder bill was an important saving in the season's expenses.

In practice, the monitors are kept going until 40 or 50 of these boulders are piled up in the pit. Then the monitors must be shut down while the boulders are being drilled and shot, so that the economy of time accomplished by the use of the drill is important as well as the saving of powder. In other words, when the drills are used for block-holing the boulders, the monitors are kept idle a shorter time than when bulldozing was employed. Another point of advantage in block-holing is due to the fact that when boulders are drilled before shooting, they are broken up smaller than when broken by the bulldozing process, and are therefore more easily removed by the monitors.

In 1915, 6,380 boulders were drilled and blasted with the Sullivan hammer drills, and 21,955 bulldozed without drilling; or, taking 1914 and 1915 together one boulder for each 2.5 yards of gravel worked. The boulders broken by bulldozing were the smaller and flatter ones, all the sizable fragments being block-holed. Explosives for 1915 cost 26 cents per boulder, a reduction of 10 cents per boulder over 1913, when no block-holing was done. The total saving in cost of powder alone thus came to $2,833.50 for the year 1915, based on equal prices for explosives.

About once a month the mining operations are suspended for a clean-up to remove the gold from the flume. At this time the flume is extended up the bed of the

The Monitor at Work

Sullivan Hammer Drill Block-holing, Ruby Creek, B. C.

Compressor House and Mine Buildings, Placer Gold Mines Co.

pit, so that it is closer to the monitors; and the air pipe is also extended at this time, so as to bring the drills up closer to the work.

At present, the two-inch air line is 1000 feet long.

The Sullivan "WG-3" air compressor is housed in a rough shed and operated by the same water supply that works the monitors, by means of a small water wheel and belt. We are indebted to Mr. T. M. Daulton, manager, for the information contained in the above notes.

A paper on the operation of the Placer Gold Mines Co., was presented before the American Institute of Mining Engineers by Mr. Daulton and Chester F. Lee, engineer, and is published in the transactions for June, 1916.

CENTRAL AIR PLANT AT A GEORGIA QUARRY

By J. E. M. Schultz *

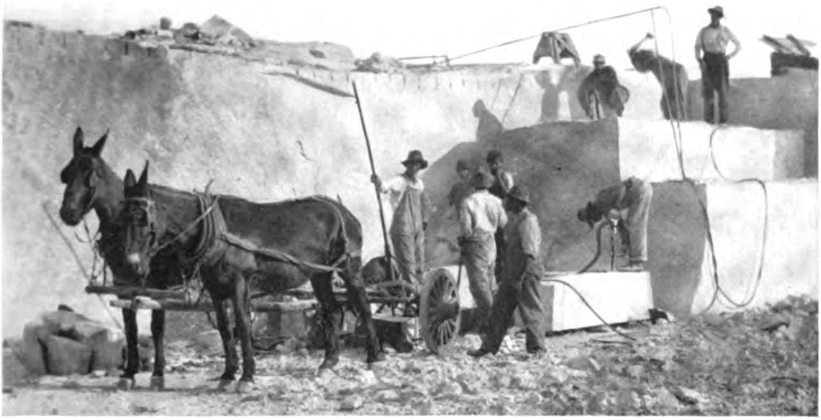
An industry of considerable importance to the State of Georgia is the quarrying of granite for paving blocks and curbing. The center of the activity is at Lithonia, in the north central portion of the state and about 30 miles east of Atlanta.

In close proximity to Lithonia, about 8 miles to the west, are the well known Stone Mountain quarries: but the main product in that district is dimension stone for building and monumental purposes, the stone being a true granite and not a gneiss, so that less attention is paid to the curbing and paving block industry than at the first named point.

Within a radius of four miles from Lithonia are some twelve actively operating quarries, chiefly engaged in the quarrying of curbing and paving blocks, with rubble and crushed stone as more or less by-products. The granite, which is more accurately described as a gneiss, outcrops over a wide area, sometimes in flat ledges, at other times in broad dome-like structures. Two of the largest properties are of the latter character, namely, the Arabia Granite Co. and the Pine Mountain Granite Company.

*Houston Bldg., Knoxville, Tenn.

Conditions are favorable for the economical production of stone. The climate is exceedingly mild; and with the possible exception of two months in the year, no discomfort or handicap is attendant on quarrying in the winter. Railroad facilities are ample, the Georgia Railroad serving the district, with but a short freight run to Atlanta, from which point, trunk lines radiate in all directions. In addition, an interurban is projected from Atlanta into Lithonia. However, the main asset is the character of the stone itself. As it is gneiss, it splits readily, a particularly desirable feature, when the rapid production of curbing and paving blocks is to be considered. As a consequence of the ease with which the stone is worked, the operating companies are able to keep their costs down to a point where they can actively and successfully compete for granite business in the Mississippi Valley and with quarries more closely situated to the large centers of consumption, such as St. Louis and Chicago.

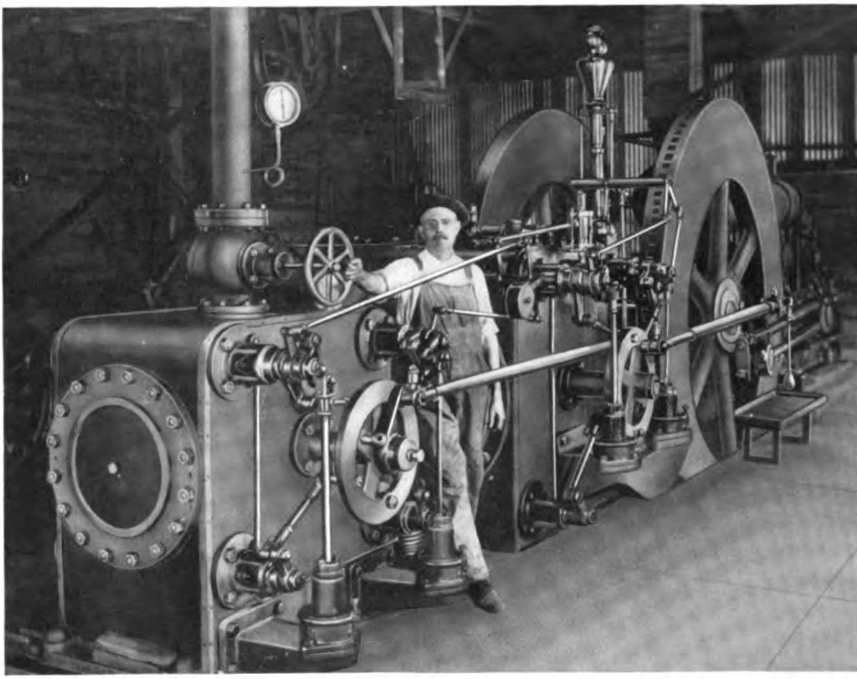


Splitting Large Blocks of Granite at Arabia Mountain; Sullivan Plug Drills at Work; the Depth and Clean Character of the Stone are Indicated by this Picture

While most recently organized, the Arabia Granite Co. is the largest in the Lithonia district. The quarries are situated about four miles from the town; a standard gauge railroad, owned and operated by the company, serving as the connecting link with the Central of Georgia Railroad. Some 200 acres of land are owned by the Arabia Granite Company, on the site of Arabia Mountain, from which the company takes its name. However, "Mountain" is a misnomer, being simply a popular application to the low-lying, dome-like mass of granite, which is high enough to slightly dominate the surrounding country. All of this acreage is almost entirely clear of overburden, and the outcrop is sufficient to last for many years to come without contending with problems of quarry drainage or removal of soil and vegetation.

Possessing such large and valuable natural resources, the organizers of the company decided to purchase the required equipment on a basis commensurate with their holdings. The most vital piece of machinery in a granite quarry is the air compressor. Upon it all the operations depend. It must produce air economically and it must be reliable in its service, ready at all times and for all demands. The Arabia Granite Company, with this in mind, purchased a Sullivan Class WC Tandem Compound Corliss Steam-driven Two-stage Air Compressor, having a rated displacement of 2450 feet of free air per minute at 100 R. P. M. The dimensions of this machine are, high pressure steam cylinder, 20 x 30 inches; low pressure, 34 x 30 inches; intake air cylinder, 30 x 30 inches; discharge air cylinder, 18 x 30 inches. This Sullivan design represents the highest development of steam-driven air compressor construction. With full Corliss valve gear on the steam end, the best of steam economy is represented; while on the air end, two-stage cylinders with minimum clearance losses and liberal intercooler area insure unusually high volumetric efficiency.

The tandem design also possesses the great advantage of occupying a minimum amount of floor space. The compressor in question is 33 feet 6 inches long by 7 feet 7 inches in width, or of approximately half the floor area needed for a cross compound compressor of the same capacity.



Sullivan Corliss Tandem Air Compressor, Forming the Central Power Plant, Arabia Granite Company

Steam for the compressor is supplied by two 175 H. P. tubular boilers manufactured by the Casey-Hedges Boiler Company of Chattanooga.*

These boilers also supply steam to a vertical, Type A, American blower engine, which is belted to a 30 KVA Westinghouse generator, which in turn provides power for driving the machine shop equipment of lathes, drill presses, etc., for pumping water required for the boilers and air compressor and for lighting the power house. The latter building is 50 feet by 65 feet in size.

Five-inch air mains are carried out from the power plant to the surrounding quarry. Nearly a mile and a quarter of five-inch main and three quarters of three-, two-, and one-inch pipe lines connect directly with the ledges and cutting sheds. The use of a large feed line results in a minimum drop in the air pressure. A pressure gauge one half mile from the compressor plant shows less than five pounds loss. An air pressure of ninety pounds at the power plant is found to be ample.

The Arabia Granite Company employs some 200 men, including 40 block makers and 38 curb cutters. In addition, it leases out portions of the quarry to smaller operators on subcontracts. There are at the present time, eight such firms engaged in quarrying out stone for curbing and paving blocks and finishing them ready for delivery. These operators, including W. R. Watson, W. D. Abbott, E. O. Reagan & Co., Powell & Wright, J. W. Haygood, E. C. Powell, and Francis Jones Co., employ 165 men. Another

*Incidentally it may be noted that the Casey-Hedges Company is supplied with air power by a Sullivan Compressor identical with the one just described.—Editor.

leaser, though independent as far as handling output is concerned, is the Arabia Mt. Stone Crushing Co., with W. S. Dallas as manager. This latter company operates a stone crushing plant equipped with No. 4 and No. 5 Gates gyratory crushers. All the above operators are supplied with Sullivan DA-15 and DF-3 Plug Drills, which are standard throughout the Lithonia district. This standardization has resulted from the common experience that the Sullivan plug drill maintains its efficiency over a longer period of time at a lower cost of upkeep than other makes of drills tested in the district.

Air for these drills is supplied from the Sullivan corliss compressor at a stated price per day per drill.

The Arabia Granite Company keeps its quarries clean by crushing all the waste stone that accumulates in getting out curbing and paving blocks. This is handled in two crushing plants equipped with No. 5 and No. 4 Champion jaw crushers, driven by slide-valve engines operated on compressed air. The capacity of these two plants together is in the neighborhood of 300 tons per day.

In addition to supplying air for the drills and crushers, the Sullivan compressor supplies motive power for one 35 H. P. double cylinder hoisting engine and three of 25 H. P., and supplies the blast for six blacksmith forges, the operation of the crane surfacing machine, and five tripod rock drills, ranging in size from 2½ to 3¼ inches. With the exception of the electric-driven pump and the machine shop equipment, every bit of machinery on the premises is driven by compressed air from the central air plant. The crushing plants were formerly operated by steam, but this has been abandoned in favor of compressed air, as being more satisfactory.

Paving Block Cutters

At this time the coal consumption at the power house averages three tons

Arabia Mountain Stone Crushing Company's Plant, Lithonia, Georgia

A Deep Diamond Drilling Rig; Sullivan "P" Drill and 64-foot Steel Derrick, Owned by the Cleveland-Cliffs Iron Company, Ishpeming, Michigan

per day, and all this, of course, should not be debited against the air compressor, inasmuch as the engine-generator set is also supplied with steam from the same set of boilers. The fuel cost of supplying compressed air for all these varying quarrying operations is thus less than three tons per day, which will be still further reduced when the compressor is run condensing, as is intended. All coal is weighed carefully so that an accurate daily cost sheet as to fuel consumed can be readily secured.

The present wage scale provides $4.00 for an eight-hour day for curb cutters, $20.00 per thousand blocks for paving block makers, with minimum wage of $4.50 for an eight-hour day. The general run of quarry hands average $1.50 for a nine-hour day, while the plug drill operators, who are on piece work, receive $3.00 to $4.00 for drilling sufficient stone to make 1000 blocks. The skilled laborers are all white, negroes predominating as general quarry hands and plug drill operators.

There is a constantly increasing demand for granite curb and block from this district. Its durability, as compared with substitutes, is more and more generally realized, and, as a consequence, new territory is opening up each year. During the past year the Arabia Granite Company has shipped its products to Columbus, Cincinnati, Ohio, St. Louis, New Orleans, Savannah, Springfield, Ohio, Louisville, Nashville, and Indianapolis, in addition to various other cities in Florida and Georgia. The rubble makes an attractive building stone and is being used largely in the Atlanta residence district.

A DIAMOND DRILL RIG FOR DEEP PROSPECTING

BY JOHN F. BERTELING*

The photographs on the opposite page show a Sullivan Class "P" drilling outfit, which is owned by the Cleveland-Cliffs Iron Company of Ishpeming, Michigan. It has bored at least two deep holes, one of which was bottomed at 2700 feet, and the other at 3000 feet. The steel derrick shown is 64 feet high and the rods were pulled in 50-foot sections, until the drill was placed on the raised foundation shown in the oval, after which 40-foot pulls were used. On the 2700-foot hole, an "N" reaming bit was used for the first 200 feet. A standard "N" bit and "N" rods were used to a depth of 2345 feet, and for the last 355 feet an "E" reaming bit was employed. The bits, clearances and fittings are shown in the table below. All figures represent inches.

Last spring, after a period of 20 months, a diamond drill boring was completed at a depth of 4900 feet, or 380 feet less than one mile. This is conceded to be the deepest core boring ever made in the United States and, so far as known, in the western hemisphere. This work will be fully described in the next issue of MINE AND QUARRY.

• Name	Blank Bit		Diameter of Hole	Casing	
	I. D.	O. D.		O. D.	I. D.
"N" Reaming	$2\frac{13}{16}$	$3\frac{9}{16}$	$3\frac{19}{32}$	$3\frac{1}{2}$	$2\frac{7}{8}$
"N" Bit	$2\frac{1}{64}$	$2\frac{25}{32}$	$2\frac{13}{16}$	$2\frac{3}{4}$	$2\frac{1}{4}$
"E" Reaming	$1\frac{1}{2}$	$1\frac{17}{32}$	$2\frac{3}{16}$	$2\frac{1}{8}$	$1\frac{5}{8}$

Other deep core borings in North America include one 3265 feet deep, bored with a Sullivan "B" drill in Northern Michigan; one of 3200 feet, sunk in the Arizona copper fields with a Class "C" Sullivan drill; and one about 3000 feet in depth in the coal district near Calgary, Alberta. This was drilled with a Sullivan Class "P" machine.

*Ishpeming, Michigan.

RECENT IMPROVEMENTS IN AIR COMPRESSORS

STAFF ARTICLE

The improvements described below relate to air compressor design of the Sullivan Machinery Company and have been introduced during the past twelve months. They include: (1) twin design for angle compound compressors, either belted or direct connected; (2) "plate" air valves of a distinctive pattern; (3) three-pass counter-current intercoolers.

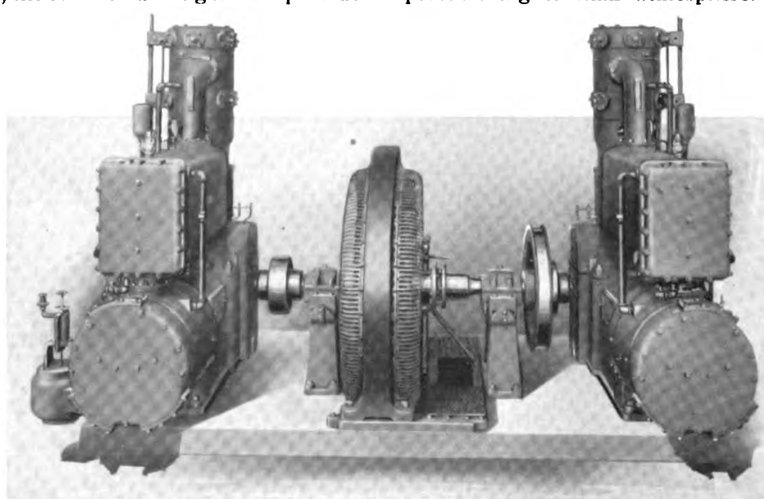
TWIN-ANGLE COMPOUND COMPRESSORS

As the name implies, the twin angle compound compressor consists of two complete Sullivan air compressors of the angle compound type set side by side on a common foundation and driven by a common shaft. As in the single units of this class, the intake cylinders are horizontal, and the high pressure cylinders vertical. The intercooler is horizontal and is supported by the low pressure cylinder and its frame. The connecting rods for both members are attached to one crank pin.

As shown in the photograph on this page, the common driving shaft is provided with couplings at each end, so that either compressor may be cut out in case the amount of air needed over a considerable period is less than one half the total capacity of the compressor. The belt pulley, or in the machine illustrated the motor, is supported on an independent frame and on independent bearings.

The air intake for each half of the machine is independent, and each intake cylinder is equipped with a standard double-beat, total closure, unloading valve.

The high pressure cylinders are also equipped with unloading valves. When the automatic unloaders on the intake cylinders close and after the high pressure cylinders have pumped out the air contained in the intercoolers (which requires only a few seconds), the unloaders on these cylinders open communication with the atmosphere, so that small quantities of air leaking in around the valve stems and piston rods are discharged without being compressed to a pressure higher than atmosphere. This



Sullivan "WN4" Twin Angle Compound Direct-connected Motor-driven Air Compressor Equipped with Special Three-pass Intercoolers and Sullivan Plate Valves

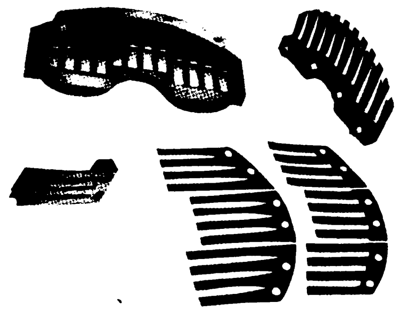
prevents heating of the cylinders and maintains a nearly perfect vacuum in which the pistons move when the compressor is unloaded. Crosshead pins, crank pins, guides and other connections are thus entirely relieved from the friction to which they would be subjected in case any pressure remained in the cylinders during the unloading period.

DESIGN SECURES GREAT FLEXIBILITY

The chief object in perfecting the twin angle compound design was to provide a compressor of elastic capacity, capable of advantageous operation at any portion of its piston displacement.

As already described, the capacity of the plant may be cut in two by removing the bolts which hold the couplings together at either end of the shaft, thus allowing one half of the machine to stand idle. The other half, consisting of a complete, independent, two-stage compressor, then operates at full capacity and efficiency as before. If desired, for short periods, the same results can be obtained by closing one of the inlet unloaders by hand. The unloaded compressor then turns over, without compressing any air, until it is again required by the engineer.

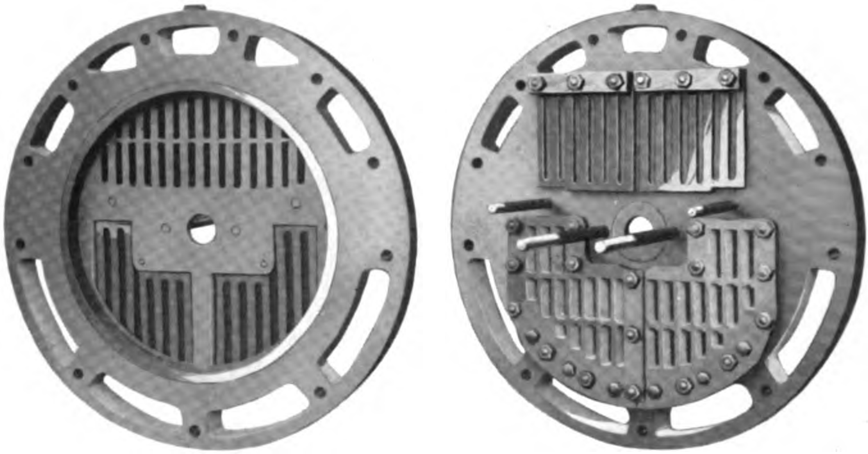
If only one quarter of the full capacity is sufficient for the conditions, as in mine development, starting a contract, or opening a quarry, one side of the unit is uncoupled, and one intake valve removed from the opposite ends of the cylinders of the remaining side, thus reducing the power required for operation as well as the air delivered. For three-quarter load, both sides of the plant would remain in commission, but on one side an inlet valve would be removed, one from the upper end of the high pressure cylinder and one from the rear end of the intake cylinder. The regular unloaders of course, provide complete elasticity of output at all times, on whatever basis the plant may be for the time; and the adjustments referred to are only made when the requirements suggested above are to obtain for days or weeks at a stretch.



Sullivan Plate Valves and Guard Plates

The advantages of a multi-unit air plant are thus fully realized in this new twin angle compound type. When the demand for air is light one unit can be cut out, leaving the other operating at full load; or one side can run at full load and efficiency, while the regulation is applied to the other only, to meet varying demands. This arrangement, coupled with the well known power economy of the total closure system of unloading, forms an almost ideal design of compressor for those districts where power is sold from a central station, on contracts based on a five-minute peak load during a given month. Under these conditions and with other compressor designs, air users have in some cases purchased compressors considerably larger than actually required by air demands, simply to avoid the high five-minute peak load with its penalizing power bill.

Another interesting feature of the twin angle design is that it enables the plant to run at the same speed as a single compressor. Two hundred and fifteen revolutions per minute would be considered out of the question for a cross compound unit of 2200 feet capacity; but the 1100-foot single angle compound compressors of which this Sullivan twin machine is made up operate with complete satisfaction at this speed, and their piston speed



Sullivan Plate Valves in Position in Cylinder Head Plates

is relatively low, so that abundant opportunity is afforded for the flow of air through the valves, and the wear on the reciprocating parts is small.

SEPARATE SHAFT BEARINGS

As stated above, the pulley or motor and the part of the driving shaft between the two compressor units are supported by separate stands and independent bearings. These bearings are adjustable for either side or vertical adjustment, a particularly important element in motor-driven machines. None of the weight of the motor is supported by the compressor bearings proper, so that the danger of motor destruction from burnt-out bearings is greatly reduced. A separate lubrication system is also provided for the motor bearings.

Sullivan Plate Valves and Cages, and their Location on a High Pressure Cylinder Head

The characteristic features of single angle compound compressors, such as balancing of reciprocating forces, with resulting smoothness of operation and power economy, small floor space, accessibility, etc., inhere also in the twin angle compound type. These are built in five standard sizes with full load ratings of 900, 1300, 1500, 1800, and 2200 cubic feet of free air per minute. Sullivan Twin Angle Compound Compressors are in extended service under numerous working conditions and are amply justifying the expectations of their designers.

SULLIVAN PLATE VALVES

Plate valves for air compressors are offered in a variety of designs by different builders. These valves are now frequently applied to compressors operating at high speeds and aim to secure rapidity of action, wide port opening with little

wire drawing effect, absence of care and wear, and a reduction in motive power.

Speaking generally, the disadvantages of this class of air valve are increased clearance losses, complication in construction, and danger of breakage with resulting damage to the air cylinder, because plate valves are frequently inaccessible and breakage is hard to detect in proper season.

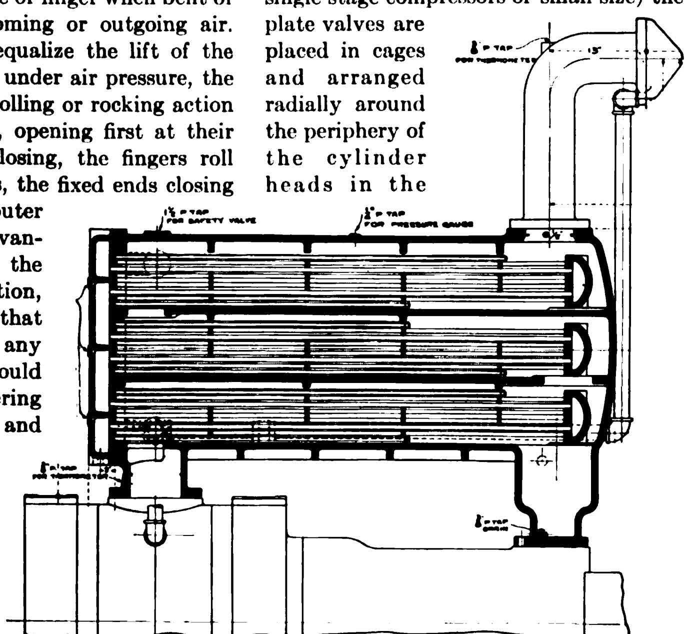
The accompanying illustrations show valves of the plate type designed by the Sullivan Machinery Company, which have certain points of interest and advantage.

As shown on page 931, this valve is of a distinctive form, shaped like a group of thin, flat fingers, made from special rolled spring steel. When in place, these valves are rigidly bolted at one end only to a steel guard or pressure plate, the other end being free. The guard plate is curved to form a rest or stop for the entire length of each plate or finger when bent or lifted by the incoming or outgoing air. The guards also equalize the lift of the valves. In lifting under air pressure, the fingers exercise a rolling or rocking action against the guard, opening first at their outer ends. In closing, the fingers roll back to their seats, the fixed ends closing first and the free outer points last. Advantages claimed for the "end rolling" action, as it is called, are that it is free from any bodily lift that would produce a hammering or slapping effect, and that it secures freedom from breaking and leakage in a high degree.

The idea for the design of these valves was obtained from the familiar band saw, which is continually bending and straightening about its pulleys. As the radius of curve of the valve guard plates is far larger than that of the pulleys, the durability of this form of valve, made of band saw steel or its equivalent, is evident.

The cuts at the head of page 932 show how the valves are set, in plates or end walls, situated between the cylinder barrel and the heads. The left-hand plate shows the cylinder side, the right-hand, the head side, of these end walls. The position and construction of these valve plates reduces clearance loss to a minimum for this type of valve. The inlet valves are placed in the lower half of the plates, the discharge valves in the upper half. The cylinder heads are fitted with hand holes and cover plates, to permit removal of the valves without disturbing either the heads or cylinders.

In the high pressure cylinders (or in single stage compressors of small size) the plate valves are placed in cages and arranged radially around the periphery of the cylinder heads in the



Sullivan Three-pass, Counter-current Intercooler, Sectional View

same manner as automatic poppet valves are set on Sullivan compressors of ordinary type. Each cage contains two valves, each consisting of two fingers which run lengthwise in the cage. These are equipped with guards of the same form as those already described. (See foot of page 932.)

The "WN-4" air compressor, illustrated on page 930, is fitted with these new plate valves, which have received exceedingly thorough tests lasting over a period of more than two years. Their simplicity, accessibility for inspection or removal, and great wearing strength constitute important advantages.

SULLIVAN THREE-PASS INTERCOOLER

The full advantages of the two-stage compression of air are not realized unless the heat generated in the intake cylinder is thoroughly removed before it reaches the high pressure cylinder. While cylinder water jackets are valuable aids in this regard, this cooling depends in the main on the intercooler. In all Sullivan two-stage compressors the intercooler consists of a nest of tubes made of copper or aluminum, substances of high conductivity, through which the cooling water passes. In ordinary practice, the current of water enters the intercooler at one end, traverses one half of the tubes and returns through the other half to the starting point. The air is forced by baffle plates to take a zigzag course across the tubes and comes in contact with them three times in passing from one end of the intercooler to the other. While effective for ordinary conditions and with cooling water of ordinary temperatures, there has been some call for intercoolers of unusually high effectiveness for localities where the temperature of the circulating water is high, or where the greatest efficiency possible is desired.

For these conditions, the Sullivan three-pass, counter-current intercooler has been designed. It is shown on page 930 as applied to a Sullivan Twin Angle Compound "WN-4" Motor-driven Air Compressor.

The cooling surface of this intercooler consists of three nests of copper tubes, through each of which cooling water circulates, entering at one end, traversing one half of the tubes, and returning through the remainder. The ends of these tubes are expanded into headers, the outer header being bolted against a packed joint on the outer end of the intercooler body, while the other header, inside the intercooler body, is left free to move with the expansion and contraction of the tubes. Suitable baffle plates are placed in the interior of the body, so arranged that the air, in flowing through it, is compelled to pass three

Lining the Asphalt with Channeling Bit

Removing the Asphalt with Drill and Gad

times across each nest of tubes, thus insuring a thorough cooling effect.

The course of the air is opposed to that of the water, thus obtaining the greatest possible cooling value from it. The tubes and the three compartments in which they are placed are housed in a rectangular cast iron shell. The three-pass intercooler is shown in section by the cut on page 933.

HAMMER DRILLS REMOVE ASPHALT PAVEMENT

By J. H. Henning*

The adaptability of hand air-hammer drills to numerous special purposes was illustrated in an interesting manner a year or two ago by P. J. Moran, a Salt Lake City contractor.

Mr. Moran secured a contract which required the removal of a strip of asphalt and concrete pavement on Main Street, Salt Lake City, alongside the tracks of the street railway, so that the rails might be shimmed and new pavement laid. In order to reduce time and labor in this work, Mr. Moran purchased two Sullivan DC-19, 40-pound hammer drills, operated by a small steam-driven air compressor.

A line was laid out a foot from the outside of the rails and the drills were equipped with a special channeling bit, (see the cut on page 934) to cut off the asphalt. When a sufficient distance had been channeled a gadding bit was used and the surfacing material was removed, as shown in the second picture, exposing the concrete. The gadding bit was again used in breaking up the concrete. This was done by holding the drill in a nearly vertical position for wedging off pieces of the concrete. In this manner pieces from four to eight inches square were broken off.

One man with the Sullivan drill was able to take up the asphalt and concrete at an average rate of six lineal feet in fifteen minutes; while three men, "double-jacking," by the old method of hand work, required an average of forty minutes to remove a like amount; that is, hand work required two hours to accomplish the same results secured in fifteen minutes with the machines.

*Kearns Bldg., Salt Lake City.

It would seem that two or three drills of this or similar type, and a gasoline engine-driven portable air compressor to operate them would form desirable equipment for contractors having road and street repair work to perform. The following comparison, based on the job described above, may be interesting.

This shows that the cost of machine work would be less than half of hand work, as follows:

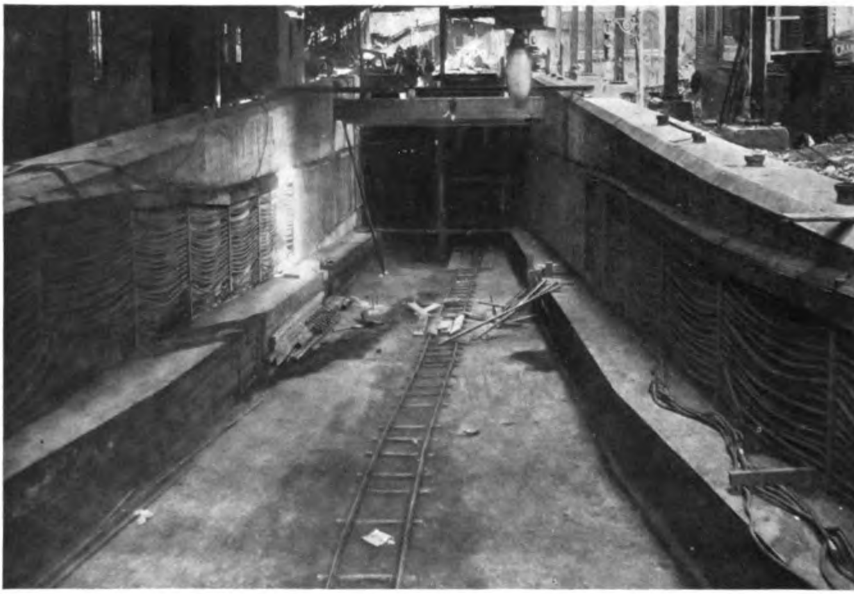
MACHINE WORK COSTS

[Based on Costs and Prices in June, 1914]

Cost of Plant:	
1 Sullivan WK-3 Portable Compressor outfit (20 H. P.).....	$1,780.00
2 DC-19 Hammer Drills........	170.00
Hose, steel, etc...............	50.00
Total....................	$2,000.00
Interest on plant, at 6 per cent.	$120.00
Depreciation, 15 per cent......	300.00
Total.....................	$420.00
Operating, 175 days per year, per day......................	$2.40
Engineer, per day.............	3.50
2 drill operators at $2.50.......	5.00
Gasoline, 20 gallons at .23.....	4.60
Oil, Waste, etc................	.50
Total......................	$16.00
Progress per day, 8 hours, 384 feet......................	
Cost per foot of work..........	.416

HAND WORK COSTS

6 laborers at $2.25............	$13.50
Progress per day, 8 hours 144 feet	
Cost per foot of work..........	.0937
Saving on machine over hand work, per foot..............	.0521



General View, Van Buren Street Tunnel Alteration

Pneumatic Concrete Equipment in the Van Buren Street Tunnel

The cash saving, however, is not the only factor to be reckoned with, as the time saved, though it represents no actual cost value, is of considerable importance in large cities as it is imperative on work of this nature that the delay to traffic be as short as possible.

[Other work, in which an outfit such as that described above has demonstrated its value, includes rock excavation in grading and foundation work; cutting pipe trenches in rock for sewer, water, or gas mains; calking pipe joints; riveting work on buildings or bridges or elevated railways; removing and cleaning paving brick, etc.—EDITOR.]

PNEUMATIC CONCRETING OF THE VAN BUREN STREET TUNNEL

BY H. B. KIRKLAND*

One of the more recent uses to which compressed air has been adapted is the mixing, conveying and placing of concrete. This process depends upon adiabatic expansion of the air, which is released through an eight-inch pipe and carries a half-yard batch of concrete at a time. This process has been used mostly for tunnel lining work and a recent example is that of the Van Buren Street Tunnel of the Chicago Surface Lines.

The Van Buren Street tunnel carries a double track street railway under the Chicago River and under the tracks of the Union Station. The proposed new Union Station required certain subpassageways which would be interfered with by the location of the Van Buren Street tunnel and for this reason it was necessary to change the grade so that the tunnel would pass under the proposed passageways of the new station. To make this change a new grade was established, lowering the tunnel under Canal Street, about 15 feet, and a new section slightly less in width than the old tunnel, was designed. First the side walls and roof of the new tunnel were built, but instead of being carried down to their proposed depth in the first construction operation, these walls were built to the level of the old tunnel floor or invert and then the new roof was built upon them. Afterward the new side walls were extended down to the new level by underpinning, that is, alternate 10-foot sections of wall were excavated and filled with concrete down to the depth of the wall, and the remaining 10-foot sections were excavated and filled after the first sections had been completed. After the walls were carried down to the new level, the core of earth was excavated, and the concrete invert constructed, thus completing the tunnel section.

Most of the concrete was mixed and placed by the pneumatic method. Inasmuch as the section of tunnel which was lowered was only 700 feet long, it was possible to locate the pneumatic mixer with bins above it at about half way between the ends of the work, thus making the maximum distance which it was necessary to convey concrete, about 350 feet. This central point was at the tunnel portal. Bins were located here over the mixer, and the top of the bins came to the level of the street, so that materials brought in motor trucks were dumped directly into the bins and ran by gravity directly into the mixer.

The pneumatic mixer consists of a conical shaped hopper with a door at the top which is closed air tight after receiving each batch of unmixed ingredients for concrete. Air is admitted into the mixer at 80 to 100 pounds pressure above the batch and also below it, at the point of the conical shaped hopper. The lower air pipe is directed at the center of the 8-inch conveyor pipe which leads away from the machine to the point for depositing

*123 W. Madison St., Chicago.

concrete. This stream of air mixes and conveys the concrete. The other air, admitted above the batch merely forces the batch downward and into contact with the lower air stream. An air receiver of about 120 cubic feet capacity was located near the mixer and air was supplied by a Sullivan angle compound motor-driven air compressor, belt connected. The compressor had a rated capacity of 628 cubic feet of free air per minute, a size which is ample for placing one batch of concrete per minute at a distance of 300 feet. For shorter distances the number of batches could be increased and for a longer distance, the batches are less in number per minute.

The amount of air consumed in general in the mixing and placing of concrete by this method, is dependent on the specific gravity of the material conveyed, the size of pipe used, the size of storage reservoir, the horizontal and vertical distance of discharge, the number of bends in the discharge pipe, and last but not least, upon the operator.

A table of theoretical capacities for continuous operation is given in Table I.

The figures in Table I are based on observation for the shorter distances of

TABLE I

Distance, feet	100	200	500	800	1,000	1,200	1,500	2,000	2,500
Time of shooting, minutes	10	15	25	40	50	60	75	100	125
Time of loading, seconds	20	20	20	20	20	20	20	20	20
Time per batch, seconds	30	35	45	60	70	80	100	130	145
Batches per minute	2.0	1.8	1.3	1.0	.85	.75	.6	.46	.41
Batches per hour	120	108	78	60	51	45	36	27	24
Yards per hour	40	36	26	20	17	15	12	9	8
Actual free air required, cubic feet per minute	400	720	1,300	1,600	1,700	1,800	1,840	1,840	2,000
Size of air reservoir, cubic feet	50	100	150	240	300	360	450	500	750

TABLE II — CUBIC YARDS OF CONCRETE PER HOUR, MIXER CAPACITY ½ CUBIC YARD

Actual amount of compressed air required. Cu. ft. of free air per minute.	Length of horizontal discharge					
	100 Lin. ft.	300 Lin. ft.	400 Lin. ft.	600 Lin. ft.	800 Lin. ft.	1,000 Lin. ft.
600	20	15	10	..	..	..
800	30	20	18	12	6	..
1,200	40	30	25	20	12	8

TABLE III — TIME-STUDY NO. 1

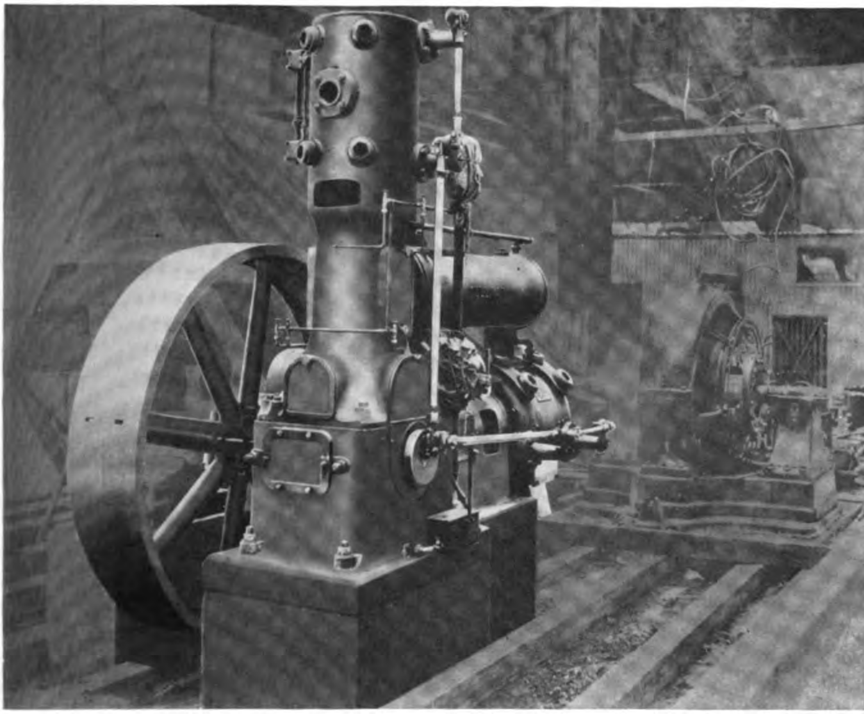
Consec. No. of shot.	Charging mixer, sec.	Closing door, sec.	Discharging mixer, sec.	Wait for rise in air pressure, sec.
1	10	4	13	23
2	10	2	13	11
3	9	3	17	15
4	8	5	14	16
5	10	5	17	20
6	11	2	20	14
7	11	6	19	20
8	9	6	15	19
9	10	5	18	..
Average	9.8	4.2	16.2	17.2

Average time per shot, 47.4 seconds. Length of conveyor pipe line, 315 feet. Vertical rise of pipe, 15 feet. Bends in pipe, 270 degrees.

TABLE IV — TIME-STUDY NO. 2

Consec. No. of shot.	Charging mixer, sec.	Closing door, sec.	Discharging mixer, sec.
1	8	3	7
2	5	3	11
3	9	1	9
4	7	4	8
5	6	4	9
6	7	5	9
7	5	5	12
8	7	9	11
9	6	3	10
10	5	5	11
11	7	5	10
12	5	4	13
Average	8.7	4.4	10.0

Average time per shot, 23.1 seconds. Length of conveyor pipe, 102 feet. Vertical rise of pipe, 37 feet. Bends in pipe line, 205 degrees.



Sullivan WJ3 Angle-compound Compressor that Supplied Air for Concreting the Van Buren Street Tunnel

discharge and are computed for the longer distances. At the St. Louis Waterworks Tunnel the air consumption was from 1.2 to 1.7 cubic feet per lineal foot of discharge pipe. At the Richmond Tunnel, San Francisco, the consumption was 1.3 cubic feet per lineal foot of pipe. Another tabulation given by H. A. Leeuw and stated to be based on three years' study and experience is shown in Table II.

Time Studies.— Tables III and IV give two time studies which were made during the course of a regular day's run on one job. The air supply was about 600 cubic feet per minute and a half-yard mixer was used. It was charged by hand, from overhead bins operated by sliding gates immediately over the measuring hopper; two laborers controlled the sand and stone gates and one laborer operated the gate to the measuring hopper and also the air valves. Still another laborer operated the water valve and assisted the mixer operator, making five men at the mixer.

Note that a 600-foot compressor was used and that the average time of waiting for the air pressure to come up was 17.2 seconds in time study No. 1, in which the distance was 350 feet. In study No. 2, in which the distance was only 102 feet there was no wait for air pressure.

The Van Buren St. tunnel work was done by the Chicago Surface Lines, under direction of Mr. John Z. Murphy, Electrical Engineer and Mr. J. W. Harris, Tunnel Engineer.

The equipment for mixing and conveying concrete is patented and was furnished by the Concrete Mixing & Placing Company, 123 W. Madison Street, Chicago.

KEEPING TRACK OF STOCK

By C. Henry*

In the travels of our engineers through the different mining fields, we have found so many different systems of keeping stock that it has occurred to us that a brief article, giving an outline of the stock keeping system in the offices of the Sullivan Machinery Company, may benefit some of our readers, not only in keeping track of their small stock of spare parts, which are most needed for their machines, but at the same time preventing the accumulation of an overstock of parts, thus keeping the investment in spares down to a minimum.

From our experience we have noticed that in many cases, when a part is broken on the machine, the stock clerk thinks he is going to have trouble with this particular part and orders a large quantity, thus often establishing an overstock on this item and making a useless investment. With the system of keeping stock described below, he has continually before him the history of every part, so that the stock can be kept down to a minimum.

In order that our system of keeping stock may be made clear, a cut made from an active stock card is shown below.

This card is printed the same on both sides so that it may be used for a number of years, and a complete record kept, which tells, at a glance, the activity and the history of each part on the machine.

The first space at the top of the card is intended for the piece number of the spare part. In this case it is "2223 CE"; the symbol "CE" shows to us that this part is used on our coal cutters. (In the case of a hammer drill part, the symbol would be changed to correspond to the type of drill used, and the same way with any other machine.) The next space is for the name of the part, which is "Wood Handle Only." Under "Size" is shown the type of machine the part is used on. In this case the part is for the "CE" and "CE-6" types of chain machines; the price being $1.15. Under the heading "Catalogue Number" is shown the serial number by which the customer orders.

FORM 400 30M 1 12

PART NO. 2223 CE NAME Wood Handles Only

SIZE CE & CE-6 PRICE 1.15

CAT. NO. 99157-98157 SEC. 1 BIN 195 BASE 5 AMT TO ORDER 3

MO.	S. T. NO	QUAN ORD	DR RECD	CR SHPD	BAL.	MO.	S. T. NO	QUAN. ORD.	DR. RECD	CR. SHPD.	BAL.	MO.	S. T. NO.	QUAN. ORD	DR. RECD.	CR. SHPD.	BAL.
	January 1st-1912				6		FORWARD				4		FORWARD				
1	22			2	4	11	1116		4		8						
1	40	4	✓			12	1462			2	6						
1	90			1	3	12	1519			2	4						
2	40		4		7		Jan. 1, 1913				4						
2	180			1	6	1	19	4									
3	220			1	5												
4	360	3	3		8												
5	370			1	7												
5	398			1	6												
6	518			2	4												
7	712	4	✓														
7	730			1	3												
8	915			1	2												
8	712		4		6												
9	1018			2	4												
10	1116	4	✓														
	TOTAL			13			TOTAL						TOTAL				

*Equitable Bldg., Denver, Colo.

The figure "5" in the next space, marked "Base," indicates the lower stock limit. When stock is reduced to this point, an order is placed with the factory for a sufficient number to bring the total on hand and ordered up to the total of the "Base" and the "Amount to order." The "Base" is equivalent to a four or five months' supply based on the shipments of each individual part, and the "Amount to order" is taken as approximately half of the base. Experience has shown that such an arrangement will take care of all ordinary demands and also avoid an accumulation of overstock. The "Base" and "Amount to order" are increased or decreased from time to time as the average demand changes. Of course, no operator would want a base as high as this, because the manufacturer must supply this part for a large number of machines, while their requirements would be for a comparatively few machines.

Every item which is shipped from our stock requires a shipping order; this order bears a serial number, the date shipped, and amount shipped, etc.

Our present system was put in force January 1, 1912, when the above card was made out, and at that time there were six No. 2223 Wood Handles only in stock, as the card indicates. The "Base" and "Amount to order" were determined from the movement of this part in the past.

During January on our Order No. 22, two of these handles were shipped to a customer, leaving a balance on hand of 4, bringing the number on hand below "Base." We then inserted immediately in front of this stock card a triangularly shaped red card, as a warning to the stock man that some of these parts must be ordered from the factory. These red warning cards extend a fraction of an inch above the stock cards, so the stock man can tell at a glance all of the parts that should be ordered when he puts in his regular requisition to the factory.

A similar process is going on with other parts of machines, so that each week the requisition to the factory covers all items that are needed.

On requisition No. 40, four of these handles were ordered as the card indicates. Before these are received one is shipped on Order 90 leaving a balance of 3. The four ordered on Order No. 40 are received in February, bringing the balance on hand up to seven. The other figures that follow explain themselves as to transactions in this part during the balance of the year 1912, and on January 1, 1913, our inventory shows four on hand.

In the case of coal companies, particularly, which find it necessary to carry a stock of parts for various machines, such as haulage locomotive parts, pump parts, etc., the red card could be elaborated to a great extent. For instance, instead of using a red card for all classes of machinery, say that the red card was used for Sullivan machine parts, a green card for haulage locomotive parts, and a blue card for pump parts, etc. Still another system might be used, that is: have printed across the top of the card "Sullivan," on another "Locomotive Parts," and still another "Pump Parts." With stock cards marked in this way, it would necessitate only a glance to pick out the parts needed for the various machines.

The stock room is divided up into sections. For example: all chain machine spares are kept in one section called "No. 1." Rock drill spares are kept in one section, which is called "No. 2," etc., so under "Section" on this card is shown the figure "1," and immediately we know approximately the location of this part. The bins all carry a separate number and are numbered consecutively.

This system has been in use by the Sullivan Machinery Company in all of its branches since January 1, 1912, after trying out various other schemes, and has been found to be most effective.


SULLIVAN

MINE AND QVARRY

REG. U. S. PAT. OFF.

VOL. X, No. 1 | MARCH, 1917 | WHOLE No. 32

Mining at Joplin, Missouri, with a Sullivan "Rotator"

THE ANNEX CREEK TUNNEL

DRILL SHARPENING METHODS

BRITISH COAL FIELDS

PVBLISHED BY THE SVLLIVAN MACHINERY CO. 122 S. MICHIGAN AVE., CHICAGO.

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MINE AND QUARRY

REG. U. S. PAT. OFF.

VOL. X, No. 1 | MARCH, 1917 | Whole No. 32

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address.

MINE AND QUARRY is behind the President, too.

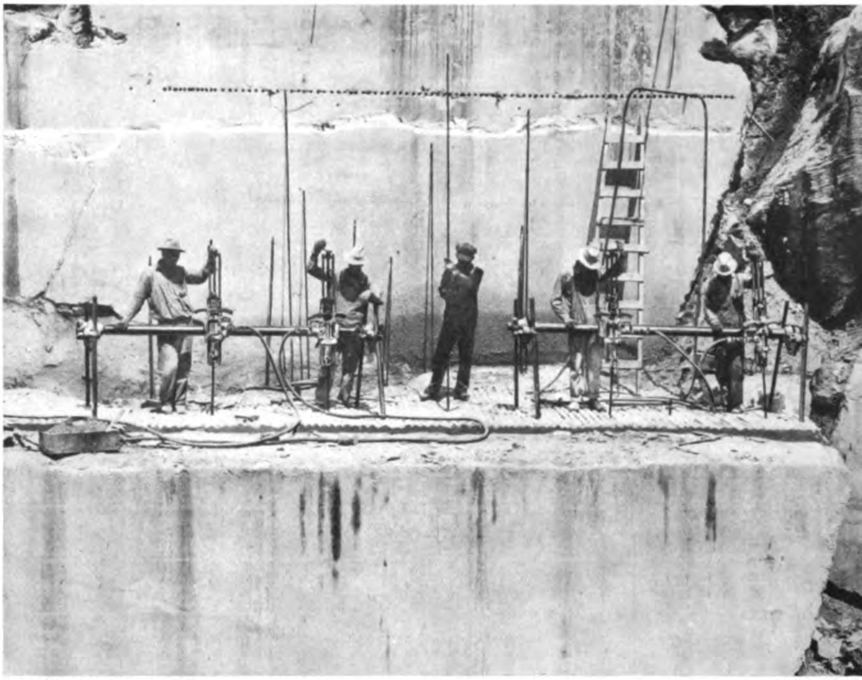
So far as MINE AND QUARRY is informed, the use of machine drill sharpeners for making channeler bits is something new. Such an application and the great advantages which it secures are described elsewhere in this number. These advantages are so important and so evident to every user of channelers as to command general attention among quarry men and contractors.

The editors are glad to give space in this issue to an article, which has been printed already in two other journals, by an authority on drill sharpening methods. Mr. O'Rourke's article won the first prize offered by *Engineering News* for the best paper on "Methods in a Drill Sharpening Shop." The author's experience covers nearly twenty-five years of active field work as blacksmith's helper, blacksmith, machinist in building drills, expert steel man, drill demonstrator, drill salesman, and finally superintendent of ground breaking of a large mining corporation. The proper care and handling of drill steel is one of the most serious studies and responsibilities of the modern mine, quarry and construction superintendents of today. The best steel on the market and the best drills on the market are both ineffective unless the blacksmith shop does its part, so that Mr. O'Rourke's discussion of sharpening practice is being read with active interest by everyone having to do with rock excavation.

MINE AND QUARRY takes the opportunity (a little late) of wishing its readers a Happy New Year and a prosperous one. It desires to retain on its mailing list all present readers if their interest is still active in the mining, quarrying or construction field. At long intervals MINE AND QUARRY sends out, not a bill for subscription, but a request for an expression of continued interest on the part of its readers. Will you kindly use the enclosed postal card to let us know whether we shall continue sending the magazine to you this year or whether you desire us to cut your name off our list? Please note that a space for "new subscription" is also provided on the card. New readers are requested to check this space on the card, so that we may be sure to classify them correctly when adding their names to our list. MINE AND QUARRY has many good things in store for the remainder of the year and hopes to deserve the continued approval of its readers.

An Alaskan reader with the government engineering commission writes:

"I have been out since September and at present am located about 40 miles from Menana P.O. Reading matter is at a premium in camp. Some one sent out a bundle of papers consisting mostly of extremely radical literature on socialism, religion, etc. I had been looking over copies of "The Fatherland," "The Melting Pot," "The Masses," etc. when I happened to get hold of "MINE AND QUARRY". Believe me, I certainly enjoyed it. The picture of the drill in a Michigan iron mine on the cover looked good to me."



Sullivan Rotators Mounted on Quarry Bars at the Appalachian Marble Company's Quarry, Knoxville, Tenn. Down and Side Holes 14 Feet Deep are Drilled with these Tools to Split the Stone after Channeling

SULLIVAN DRILL SHARPENER INCREASES QUARRYING EFFICIENCY

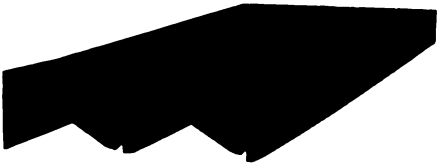
By E. L. Thomas*

The following paper describes two improvements in marble quarrying practice developed in the marble district centering about Knoxville, Tenn., which it is believed will be of general interest to quarry operators in other parts of the country. The first of these relates to the use of drill sharpening machines, and the second to the introduction of the light, powerful hammer drills or rotators to quarry bar and tripod work for dimension stone drilling.

At least two quarries in the Knoxville district, the Appalachian Marble Company and the Grey Eagle Marble Company, now own Sullivan all-hammer type drill sharpeners, which have replaced hand blacksmithing at their quarries entirely. The Appalachian Marble Company operates one Sullivan 6½-inch steam channeler, four Sullivan Rotators mounted on light quarry bars, three Sullivan "DB-15" hand rotation hammer drills, used in the stone yard for trimming blocks, etc.

The output is 4000 to 5000 cubic feet per month. The Sullivan drill sharpener is used for forming the channeler bits, the shanks and bits for the ⅞-inch hollow steel used on the Rotators and "DB-15" drills, as well as for making plugs and feathers, and other miscellaneous work about the quarry.

* Houston Building, Knoxville, Tenn.



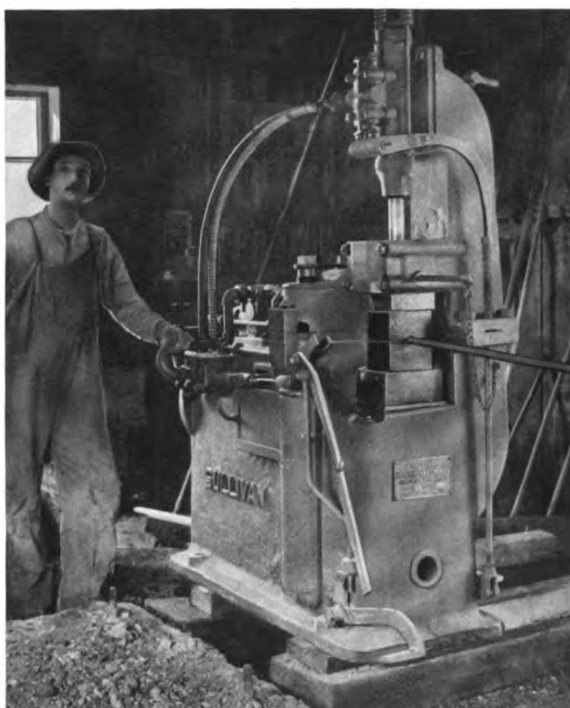
Five-piece Channeler Bit or Gang for Marble

MACHINE-MADE CHANNELER BITS

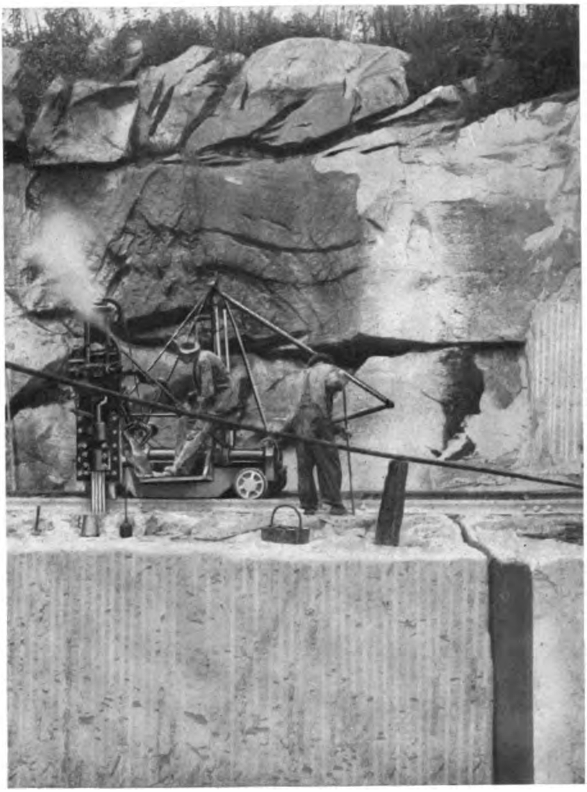
The channeler bits are the standard marble five-piece gangs with starting gauge of $1\frac{1}{2}$ inches and $\frac{1}{8}$-inch drop for each 18-inch run.

The straight and diagonal bits can be drawn out from new steel to an angle of about 22 degrees and finished to the proper gauge, in about four minutes each. Sharpening by hand, ten or fifteen minutes are required to form a single bit. The chief advantage in these mechanically formed bits is uniformity. When once the correct bit has been determined for a given stone, the shape of the individual bits composing the gang and the gauge of the gang can be maintained indefinitely with accuracy by machine sharpening, and the best results follow as a matter of course. On a recent visit to the quarry the channeler runner remarked: "When our steel was sharpened by hand, it was sent to the blacksmith shop to be resharpened after each cut. Now we use the steel for three cuts before resharpening." In spite of skillful blacksmithing, the hand-made bit lacks uniformity as to shape angle. Bits are frequently seen in the same gang, where hand sharpening is employed, in which the angle varies from 25 to 45 degrees.

There is of course, an angle which will give the best results in a certain stone with the maximum penetration for a given force of blow. The tendency of the hand blacksmith is to gradually increase the angle and form a short, stubby bit on which the cutting edge dulls rapidly. The diagonals are seldom true, the corners extend beyond the straight bits, making a wavy cut and causing the gang to spread with resulting breakage of steel. With a spread gang the bottom of the cut becomes lumpy and channeling is increasingly retarded. Steel breakage has been reduced 50 per cent since machine-made channeler bits were adopted. All things being considered it is estimated



Sullivan Sharpener being installed at Grey Eagle Marble Company's Quarry, Knoxville, Tenn.



Sullivan Improved Double Swivel Marble Channeler cutting 14 feet deep, Appalachian Marble Company, Knoxville, Tenn.

that the use of the sharpener has increased the cutting speed of the channeler by 15 per cent.

MACHINE-FORGED DRILL BITS BETTER

On the Sullivan Rotators and plug drills, ⅞-inch hollow steel is employed, with hexagon section and six-point rose bits. The starting gauge is 1½ inches, with 1/16-inch drop to each 24-inch length. Holes are drilled to a depth of 14 feet. The time of forming a six-point bit on the machine after heating is about 15 seconds and the time of forming a shank ten seconds. These are the shanks with collars. The blacksmith and helper, sharpening by hand, formerly required ten minutes for bits and 20 minutes for shanks, employing hand tools. As is the case with the channeler bit, the great advantage secured is uniformity. The two steel dies used with the sharpener form what is practically a perfect bit, with ample clearance between the wings. In comparison with them, hand-made bits are clumsy and ineffectual, lacking the clearance so necessary for rapid cutting. Points made by hand are irregular, some projecting farther than others. This impedes the rotation of the drill and seriously affects the alignment of the hole.

A quarry foreman at a neighboring installation has his bits made at the Appalachian Marble Company's blacksmith shop, sending the steel several miles to obtain the advantages of machine sharpening. He said: "Our hand-made bits are not upset far enough back. They are just flared out and the points break off. They haven't the proper clearance and don't cut as fast. Our blacksmiths may be able to make better bits but they don't do it." Before the sharpener was installed the Appalachian quarry required a blacksmith at $3.00 per day and a helper at $2.00. At present the blacksmith alone takes care of all the smithing, keeps the men's time and repairs the drills.

GREY EAGLE QUARRY WORK

At the Grey Eagle Marble Company's

plant the marble is removed entirely by drills mounted on quarry bars and tripods. Eleven piston drills are employed and seven Sullivan Rotators. Solid steel with cross bits are used with the piston drills, the starter having 1½-inch gauge and the drop being ⅛-inch per 18-inch change; ⅞-inch, hexagonal hollow steel with six-point bits are used for the Rotators. Before the sharpener was put in, a blacksmith and helper were kept busy all the time to take care of the steel for these drills. Now the blacksmith handles the entire day's work in two hours without a helper. Piston drill steel breakage has been reduced fully 50 per cent, due of course to correctly-shaped and uniform bits. This question of uniformity is of great importance in marble quarrying in order that the straight line of holes drilled with the machines on the quarry bar may be true, thus breaking evenly when the wedges and feathers are employed and avoiding waste of stone through the formation of ridges between the holes, which might require blasting.

Wedges, feathers, stone picks and other tools are made upon the Sullivan sharpener at the Grey Eagle Quarry. While neither of these installations falls within the theoretical range that has sometimes been set, calling for the adoption of a sharpener — namely, "put in a drill sharpener when you have more work than one

Sullivan Rotators Mounted on Tripods at the Appalachian Marble Quarry, Knoxville, Tenn. Horizontal and Vertical Holes 14 feet Deep are Drilled. Sullivan Channeler in Background.

blacksmith can handle," the increased cutting speed, the decrease in steel breakage and the saving in labor has made the installation of the Sullivan sharpeners at both of these plants very well worth while.

ROTATORS ON BARS AND TRIPODS

As stated earlier in this article, these two companies are employing Sullivan Rotator hammer drills for work in which piston drilling was formerly considered the standard. The Appalachian Marble Company was among the first in the vicinity of Knoxville to use these hammer drills on mountings. Their advantages were soon demonstrated, as their cutting capacity in lineal feet was shown to be 100 per cent more than that of the piston drills, while the labor cost is one-half as great. The work done with these rapid 40-pound Rotator drills is quite remarkable. The photograph on page 942 shows two quarry bars fitted with two of these drills each, the bars being ten feet long and carrying the cradle or shell and feed screw mounting, in which the Rotators are clamped by two hinged clamps with hand set screws. This picture shows to good advantage the class of work being done, and the lines of holes, drilled to a depth of fourteen feet. The four drills require five men, four runners and one helper, and replace six piston drills with two men to each drill. The photograph on page 945 shows the Sullivan "DP-33" Rotator used on tripods in the quarries of the Appalachian Marble Company. The left-hand machine is drilling vertical holes, while the machine at the right is putting down horizontal holes to a depth of fourteen feet. These two machines replace three piston drills and average 225 to 250 lineal feet per shift, each. It will readily be seen by comparison with piston drill work the great increase in cutting efficiency and the great decrease in labor cost which the adoption of these Rotator drills has been able to accomplish.

The writer is indebted to the officers of the Grey Eagle and Appalachian marble companies for information used in the above article and for the photographs taken at their quarries, which have been used to illustrate it.

CUTTING COAL WITH STEAM

Steam is seldom heard of as a motive power for operating coal cutters, but the accompanying photographs are evidence that occasionally it may be employed successfully. The pictures were taken at the open pit mine of the Mullen Coal Company, Lake Wabanum, Alberta, about forty miles from the city of Edmonton. Mr. John K. James, engineer, writes MINE AND QUARRY that they are working a 26-foot vein of coal with the Sullivan class "2" puncher and mining about four yards per hour, five feet under.

Sullivan " DR-6 " Water Hammer Drills in the Annex Creek Tunnel, near Juneau, Alaska

TAPPING A LAKE FOR WATER POWER

By B. B. Brewster*

In the summer of 1915 the Alaska Gastineau Mining Company drove a tunnel 1400 feet long to tap the waters of Annex Creek Lake and thus obtain water power for its 4000 h. p. power plant on the sea beach, two miles distant, at a point some 17 miles from Juneau. This work embodies some unusual and interesting features, due to the fact that the lake end of the tunnel was 150 feet below the water level.

The plan and section sketches on page 948 indicate some of the features of this tunnel. The tunnel proper was approximately 1400 feet long, but included a raise for safety purposes and other station work amounting to approximately 1700 feet of driving. The tunnel was driven eight by eight feet with an arched top, making it nine feet in height. The ground encountered was hard, coarse-grained granite which gave considerable difficulty in breaking. Some 22 to 28 holes per round were required, and the tunnel round included nine 9-foot cut holes, the remainder being six feet deep.

Four Sullivan "DR-6" water hammer drills were purchased for the tunnel work, two being held in reserve and two mounted on a cross bar. These drills put in rounds with 1¼-inch round hollow steel in an average of 4½ to 5 hours' work. This was considered fast drilling for the ground encountered. The average footage per month was 400 feet. Good blacksmith work kept the steel breakage very low. In addition to the "DR-6" drills, one Sullivan "DA-21" stoper was used for trimming up roof and other odd jobs, and a Sullivan "DP-33" Rotator hammer drill was also used in the open to cut a trench for the water pipe from the mouth of the tunnel to the power plant on the beach. Considerable difficulty was encountered in mucking, owing to the character of the shattered granite, which formed a wet muck resembling concrete in texture.

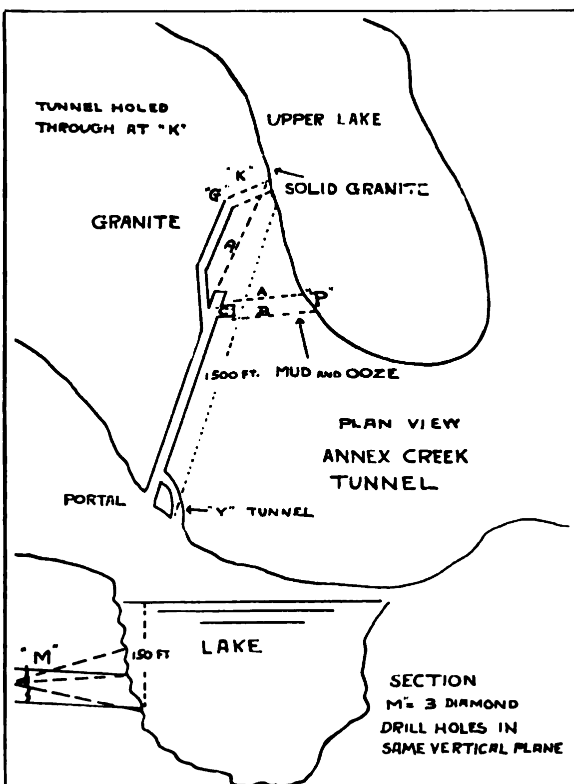
*Kearns Building, Salt Lake City, Utah.

USE OF DIAMOND DRILLS

When the tunnel had reached a distance of 1350 feet from the portal, some doubt arose as to the character of the ground ahead, and a Sullivan "Beauty" diamond drill was installed in a station at the point C shown in the sketch. With this, at points three feet on either side of this sta-

tion, three holes were drilled with the "Beauty" drill, as shown in the section at M, in the direction of P or at nearly right angles to the course of the tunnel. These were driven so as to come out as nearly as possible at the bottom, at the top and a little above the proposed tunnel line so as to give exact information as to the ground condition at the point of entering the lake. The holes bored at A and B respectively encountered muck and ooze, showing that some other point would have to be selected for the final break-through. The distance to the water was here about 50 feet.

The diamond drill hole D, almost in line with the axis of the original tunnel was then bored 86 feet to the lake, which it entered at the point K. This hole showed solid granite at the edge of the lake. An offset to the left was then taken and the tunnel continued to the point G, where another station was cut as at C, and six holes driven with the diamond drill to the water in the same manner as at C. These holes showed that the water was about 36 feet from G and solid granite was encountered all the way. All the diamond drill holes were plugged with pipe and controlled by valves so as to prevent water and ooze from entering the tunnel. The driving was then continued until the tunnel breast was six feet from the lake wall.



Annex Creek Tunnel and Diamond Drill Borings

BREAKING INTO THE LAKE UNDER 150-FOOT HEAD

The task of removing this last six feet of pillar rock with a pressure behind it due to a depth of 150 feet of water, was accomplished successfully and safely in the following manner:

A pocket was cut on each side of the tunnel for the full height. From each of these pockets two holes were driven with the regular Sullivan "DR-6" drills, one of the holes being near the top and one near the bottom in each pocket. These holes were driven through into the lake and thus gave the approximate distance from the tunnel face to the water of the lake at each corner of the tunnel. In order to control the flow of water from these holes when the drills should break through into the

lake, an extra large starting steel was used and a nipple was driven into the hole made by this steel and cemented into place; then a valve was fitted in this nipple. All the other drills used were of the ordinary size and were passed from the machine through the valve and to the rock beyond, and the remainder of the hole drilled in this manner. When the steel broke through into the lake, a mark was made on it where it entered the valve, the steel withdrawn from the hole, the valve closed and the water shut out. Then by measuring the distance between the mark made on the drill at the valve and the drill bit, the distance to the water was obtained.

This method was used on each of the four pilot holes and thus a good idea of the profile of the rock on the side next to the lake was secured. Eighty-four holes were then drilled in the face with the regular machine drills. These holes were drilled to what was estimated to be 12 inches from the water. By this time the tunnel face was making a great deal of water, which was to be expected when it is taken into consideration that 84 holes had been drilled to within 12 inches of the water, which at this point had a vertical height of 150 feet, thus exerting no small pressure. The holes were spaced about eight inches apart. Nine of them were very wet and were not loaded. The other 75 were loaded with 750 pounds of 40 per cent Dupont gelatine. The dynamite was tamped into the holes to within 12 inches of the collar and then the remainder of the hole was tamped solidly with fire clay.

Dupont No. 6 electric blasting caps were used to detonate the dynamite. All caps, wires and connections were waterproofed. Each cap was tested with a galvanometer before being taken into the tunnel and the circuit was again tested after the connections had been made. The wires strung from the roof and used for the lighting system during the driving of the tunnel were repaired, tested and used for lead wires. The tunnel made a turn about 50 feet back from the heading and a bulkhead of fine muck from the face was built up here, entirely blocking the tunnel. A similar bulkhead was constructed about 300 feet nearer to the portal.

After all connections were made and tested, the bulkheads built, etc., the outlet valves at the portal were closed and water turned into the tunnel from the outside. The tunnel was allowed to fill until the meter showed that sufficient water had entered to fill the tunnel to the bulkhead nearest the portal. A pressure gauge was then connected with the water in the tunnel and the shot was fired on February 4, 1916. At the moment of explosion the pressure gauge only registered an added pressure of 10 pounds, but the concussion was strong enough to shake the snow off the trees several hundred feet away. The head gates were then opened and the water allowed to run through the waste gate until the tunnel had cleared itself, when the water was turned into the pipe line and proceeded to generate electric power at the beach a couple of miles away.

So far as known this is the first time that a project of this kind has been attempted with the tunnel lining completed and the head gates in place at the time of firing the final blast to tap the body of water forming the supply.

The work was under the personal direction of Mr. H. L. Wollenberg, Chief Engineer of the Alaska Gastineau Mining Company and his assistant, Mr. J. A. Wilcox, assisted by Messrs. Byron Olson and Martin Donnelley.

The above enterprise, with its use of diamond drills for feeling the way ahead of the tunnel construction and with the interesting break-through methods and outfit, should be very suggestive to tunnel contractors everywhere.

The latter part of this article is adapted from one appearing in the *Du Pont Magazine* for May, 1916, by Mr. R. E. Murphy.

Map of the British Isles, Showing the Divisions Assigned to His Majesty's Inspectors of Mines, Under the Coal and Metalliferous Mines Regulation Act and the Quarries Act (1915)

BRITISH COAL FIELDS

And Some Remarks on British Machine Mining Conditions

By Our London Correspondent

The writer has noticed that comparatively few British coal operators have much familiarity with the geographical location of the coal areas of the United States, the characteristics of American coal mining and our labor conditions. As possibly there may exist among many American operators equally vague ideas of the fundamentals of British mining, these elementary observations may be of some interest.

It is well known that most British collieries are worked "longwall," which system is almost as universal as the "room and pillar" system has become in the United States. In some districts—where the seams underlie villages or cities—the "bord and pillar" system is used, but the nature of the roofs, the height of the seams and the labor conditions in Great Britain favor longwall mining as a rule. A three-foot seam is considered in some districts a good height, as many of the higher seams have been worked out. Twenty-two-inch and 24-inch seams are common, especially in Scotland. In Yorkshire, Lancashire and Staffordshire there is considerable high coal—five to six feet high.

The main and tail rope haulage system is used widely, but the endless rope method is used considerably also. No air or storage battery locomotives are in use as far as the writer is aware. As the use of a bare trolley wire is prohibited by the Mines Act in all mines, whether fiery or not, no locomotives of the usual American type are employed.

Considerably more than half all British mines are fiery pits and employ safety lamps. Electricity is used in many gassy mines, but the use of electricity underground is hedged about with many strict rules which make its use expensive, because all cables, switches and electrical equipment have to be thoroughly and conscientiously protected, insulated and tested at frequent intervals. It is considered possible in some quarters that the use of electricity at the coal face may be prohibited entirely within a measurable period of time. Five hundred volt, 50 cycle alternating current is the standard of most new installations, but a great variety of currents are in use. Only one or two collieries use voltages as low as 220. Five hundred volt, 40-cycle current is used considerably, and there are some 30-cycle installations. Direct current installations are almost all 500-volt.

The air pressures employed average about 40 pounds at the face. Many believe higher pressures are inadvisable on account of the greater loss by leakage. It should be borne in mind in this connection that it is harder to properly maintain pipe lines in longwall mines than in room and pillar mines on account of the movement of the strata, frequent instances of rising floor, etc.

EXTENT OF MACHINE MINING

Only nine per cent of British coal is machine mined. This looks odd to an American operator, especially when longwall working is so ideally adapted to machine work. It should be pointed out that (until the present war) a plentiful supply of skilled miners has been available at all times, men whose fathers and grandfathers perhaps, were coal miners and who have learned their trade thoroughly and completely. This is somewhat different from the American situation, where skilled miners are not always obtainable and European immigrant labor from non-coal producing countries has had to be used extensively to keep pace with a production which has grown tremendously during a quarter of a century. Hence labor-saving machines have not been

Sullivan Turbinair Ironclad Cutting Under in a Three-foot Seam in the Midlands, England

introduced as extensively in a country where the coal output in 1914 was only 15 per cent greater than in 1900 (as is the case in Great Britain), while the American output (in spite of a scarcity of skilled miners) has grown 90 per cent during the same period.

The total number of machines in use in the United Kingdom in 1914 was 3093 or about the same number as were in use in the United States in 1899 (3125), and it simplifies the comparison to say that the total production of coal in the two countries was almost exactly the same—that is, ours in 1899 was about what Great Britain's was in 1914. The greater height of our seams, better natural conditions, and other factors mentioned below, however, enabled us to mine about 44,000,000 tons with the same number of machines with which our British cousins produced only 24,275,000. As it is quite possible that the height of our seams mined in 1899 was more than twice the height of those mined in Great Britain, even in 1914, these figures do not reflect upon British colliery management in the least.

It is considered probable, however, that British collieries have in many fields been handicapped by the coal cutting machines available on the British market. This may be substantiated by the statement that although the first of the Sullivan machines was installed in South Wales only in June, 1914, immediately before the war, their efficiency has been so much greater than that of the machines formerly in general use, after two years the South Wales colliery managers have already replaced almost all the machines previously employed with Sullivan "Ironclads." It is believed that the production per machine in this district will soon show a material increase over the 1914 figure of 4850 tons per year per machine. As South Wales seams are somewhat higher than those prevailing in some older fields, this figure is rather surprising, being less than 20 tons per day per machine on the basis of 250 working days per year. In Scotland, where colliery managers were able to employ machines much better adapted to conditions, the production (in spite of low seams) was 10,000 tons per machine per year; this compares very well with our own 1914 figure of 13,231 tons. The natural conditions in Scotland are infinitely worse, but on the other hand longwall mining should have a considerable advantage over narrow work in such a comparison.

It appears probable that Ironclad longwall chain machines will aid materially in raising the production per machine per year.

TYPES OF COAL CUTTERS IN USE

Disc machines predominated in 1914. Out of the 2167 rotary coal cutters in use (926 of the total of 3093 mining machines being post punchers), over 58 per cent were disc, 27 per cent of the bar type, 13 per cent of the chain type, and two per cent heading machines. As the number of chain machines shows a decrease from the number used in 1911, this fact, taken in conjunction with certain others, indicates that prior to 1915, the chain machine offered British colliery managers did not fill the bill. The underlying reason for this appears to be that British manufacturers never succeeded in producing a thoroughly satisfactory chain cutter and seem to have devoted the bulk of their thought and effort to the other types. The fact that the chain type has been for years practically universal among rotary machines in the United States does not appear to have caused more than one British manufacturer of coal cutters to investigate American coal cutters, and this was a number of years ago, when these machines had by no means reached their present excellence. Some British colliery owners think that it would not have been amiss had the British manufacturers of coal cutters followed developments somewhat more closely across the

Rear or Cutter Bar End of a Sullivan Ironclad Turbinair Longwall Coal Cutter at Work in a British Mine. The machine is only 18 inches high.

water, as American automobile manufacturers followed the development of the motor car in Europe.

Sullivan longwall chain machines have been introduced with great success during the last few years. British operators are not at all slow in taking up an improved machine, once persuaded of its advantages.

Post punchers are used extensively in two British districts, with a small scattering in others. Only one or two collieries use the ordinary puncher or air pick machine on a board.

LOCATION OF THE MINES

The six divisions used by H. M. Inspectors of Mines are shown on the map, page 950 and on page 955 are shown the total output of coal and coke, their average value, and the percentage of machine-mined coal with the number of machines in use in each district according to the latest report available.

The total production for 1914 was 265,664,393 long tons, about 10 per cent less than in 1911–12–13. In 1908, 1909 and 1910 the production was almost the same as in 1914. Since 1900 the lowest year was 1901 with 219,000,000 tons and the highest 1913 with 287,000,000.

Each of these districts has one or two large cities around which it may be said to center; Glasgow for Scotland; Newcastle for Northern; Sheffield and Nottingham in the Midlands and Yorkshire; Manchester and Liverpool for Lancashire and North Wales; Cardiff for South Wales; Birmingham for Midland and South.

1. Scotland. Taking these districts in the order named, in Scotland we find most of the seams are low, roofs fair and conditions sometimes pretty difficult.

COAL PRODUCTION IN THE UNITED KINGDOM FOR 1914

District	Total Coal Production (Long Tons)	Average Value Per Long Ton at Mine	Coal Used to Make Coke (Long Tons)	Number of Mining Machines	Per Cent Machine Mined Coal
1	38,847,362	$2.18	2,826,133	913	23.4
2	52,384,582	2.43	8,674,348	702	6.8
3	68,008,829	2.18	7,459,469	725	10.4
4	26,298,534	2.49	3,706,870	399	7.9
5	53,879,752	2.96	2,445,019	131	1.2
6	26,245,334	2.18	9,428,020	223	5.5
	265,664,393	$2.40 (average)	34,539,859	3,093	9% (average)

Coal cutting machines are used in greater number in Scotland than in any other district, the latest figures showing 913, which mine nearly 22 per cent of the output. Scotch mining machine practice is for a shallow undercut (3½ feet) and an organization arranged so that the coal is cleared ready for the next machine shift. The faces are cut "to and fro" almost universally, and the disc machines used have the disc in the center, thus obviating turning, but necessitating cutting "stables" or "stalls" at each end of the face to accommodate the disc.

The coal seams mined at present in Scotland are about 2000 feet below the surface. Scotch seams, in which machines are used, are low (20 to 24 inches) and careful management is essential to secure a profit. Electricity is the prevailing power in use underground, and it is difficult to understand how some Scotch pits could be run at a profit if they were compelled to abandon the use of electricity. This would indeed seem a hardship in a district where open lights are the rule rather than the exception, about 60 per cent of the output coming from open light pits.

2. North of England. The North of England district formerly exported a large portion of its coal to continental countries and has been hard hit by the war. This district is made up practically of only two counties — Northumberland, lying mostly north of the Tyne, and Durham, lying south of it. Northumberland coal is largely used by gas plants; while Durham is by far the largest producer of coke of any county in the United Kingdom.

The seams mined in these counties are found at a depth of 500 to 1500 feet; there are a few drift mines. All the seams dip to the sea, and are thinnest as they approach it. As in the other British coal fields, many of the higher seams have been worked out. Electricity is used considerably at the coal face; in Durham perhaps 95 per cent of the pits use safety lamps and in Northumberland about 85 per cent. A considerable number of post punchers (451) is used in this district, in fact it leads all other districts in the number of percussive coal cutters used. There is considerable "bord and pillar" mining in the district.

3. Midlands. The third district is the largest district of all, and embraces a great manufacturing area. The Midlands collieries are shaft propositions, and the coal at present mined is found at depths ranging from 300 to 2500 feet. The amount of coal mined by air and electric machines is almost the same. Perhaps nearly half the pits are fiery and employ safety lamps. The present seams vary in height from two to six feet.

4. Lancashire. The fourth district embraces some of the largest manufacturing cities in England and the second largest city, viz., Liverpool. The Lancashire mines are very fiery and electricity is seldom used at the coal face. There are 399 percussive machines driven by air

in use in the district. One pit is hoisting coal from over 2700 feet. The North Wales district is small, and the production of Ireland (which is also included in this district) is not of serious consequence.

5. South Wales. The South Wales district is famous for its steam coals. Nature, however, has not been kind in the matter of natural conditions, as the roofs are frequently bad and the seams faulted. South Wales consists of a series of valleys lying between hills of fair size. The country has been subject to more geological disturbances than most of the other coal fields of Great Britain. There are a good many slope mines in this district, but shafts predominate. More than 90 per cent of the mines are fiery and use safety lamps. One seam has recently been opened at a depth of over 2700 feet. The better grades of steam coals come from near the surface.

Coal cutting machines have been used less in South Wales than in any other district, but there are more seams which can be worked profitably by hand in this district than in some of the others, and as it is the newest coal field, the present coal seams are of slightly greater height, probably averaging better than 3½ feet. During the past two years chain machines have practically supplanted the bar machines, which were almost the only ones in use previously. Compressed air is mostly used for cutting coal, but considerable coal is still cut by electricity.

The biggest anthracite field in Great Britain is in the southwestern part of South Wales. There is, however, a little anthracite produced in Scotland and Ireland. The total production of anthracite in 1914 was 4,718,993 long tons. Machine mining has not progressed far in the anthracite field, but the SULLIVAN IRONCLAD machine has been recently introduced and given very excellent results, so that a better impression of mining machines is being formed in this district. Cardiff, the shipping point for the South Wales district, is a city which has grown more rapidly than any other in Great Britain during the last generation. It is noted for its cosmopolitan population and the tremendous tonnage shipped, the docks being equipped with modern coal handling devices.

In the South Wales district face conveyors are coming rapidly into use. In fact the last year has seen a considerable advance in the use of conveyors. The shaking conveyor of the Eichkoff type, which is now made in England, seems to have been found best suited to the conditions. As yet most of these conveyors are used on hand-mined faces, but some of the more progressive managers are working conveyors and machines on the same face, where roof conditions permit. The mine cars used in South Wales are somewhat larger than in the other districts, ranging from 15 to 25 cwt. capacity as compared with an average of 10 cwt. capacity elsewhere. In some districts, the capacity of cars runs as low as 300 pounds.

As an indication of the disturbed nature of the formation in South Wales, it may be mentioned that one of the largest collieries in the district recently drove a rock tunnel, and although the tunnel was completed six months ago, not a ton of coal has gone through it at the time of writing (September, 1916), as it was necessary to place steel girders a foot or less apart in order to hold the ground. The removal of the large quantities of coal which have come out of this district in the last few years, and the fact that the country is hilly, introduces special mining problems. The district mentioned mines about the same quantity of coal as the Newcastle district.

6. Midland and South. In the sixth district nearly all the collieries are shaft propositions, and the coal seams at present mined are from 1800 to 2000 feet below the surface. The Black Country, viz. around Birmingham, comes in this district. The counties of

Staffordshire, Warwickshire, Worcestershire and Gloucestershire are responsible for most of the output. In fact, there is no coal mined in a great many of the counties shown in this inspection district. The coal fields of the county of Kent, which lies southeast of London, are receiving some attention at the present time.

GENERAL FEATURES

The shafts (which are usually round) run from 10 to 24 feet in size, the later ones being usually 22 or 24 feet in diameter. Some oval shafts and some of rectangular shape are in use. Practically all coal cutting in England is done on the night shift, loading and hoisting being done during the daylight hours. The length of shift is usually eight hours.

Board of Trade returns give the coal output for the first half of 1916 as 128,135,000 tons, an increase of 515,000 tons, or 4/10 of one per cent over the first half of 1915, in spite of a four per cent decrease in the number of mine workers. This is, however, a decrease of 11,859,000 tons, or 8.5 per cent as compared with the first six months of 1914, when the number of persons employed was 14.3 per cent greater.

The Paris, France, office of the Sullivan Machinery Company is now situated at No. 18 Ave. Parmentier. Mr. E. J. Rossback, formerly associated with the Company's St. Louis office, is manager, with Mr. C. F. Bernard, an engineer of wide European experience, in direct charge of sales. Mr. Bernard returned to Paris on the French liner Espagne, February 16, after six weeks spent at the Company's factories.

Front View of a Sullivan Compressed Air Longwall Machine Cutting in the " Deep Hard " Seam, Derbyshire, England. The Machine Travels in a Space 30 inches Wide, Between the Face and the Props.

CLEANING PAVING BRICK BY COMPRESSED AIR

By C. G. Cummings*

During the past few years an increasing variety of practical uses has been found for a portable, self-contained, motor-driven or engine-driven air compressor which can be readily moved about from place to place to furnish compressed air power for different purposes. Such purposes include the operation of hammer drills for rock excavation in road work, cutting trenches for water, sewer and gas pipes, removing old asphalt or concrete pavement, operating riveters for structural steel and bridge work, driving hammer drills for rock removal in building foundations, block-holing boulders in quarries, street grading, etc.

An interesting application of one of these outfits, not hitherto described, was developed some four years ago by Mr. C. F. Crowley, Commissioner of Public Works of the city of Troy, New York. This consists in removing and cleaning old paving brick. The equipment used for this work, which was purchased in 1913, consisted of a 15 h. p. Sullivan class "WK-3," portable, single-stage air compressor, the compressor being operated by a gasoline engine, mounted on the same truck with the compressor, as shown in the cut on page 959, and operating the compressor through a gear and pinion. This outfit furnishes compressed air for a Sullivan "DA-15," 25-lb. plug drill, and a Sullivan "DB-13" hand bushing tool equipped with bits like that on a cold chisel. The larger of the two tools is used for tearing up the brick, and the smaller for cleaning the old mortar and grout from them. With the plug drill one man can remove about four square feet of pavement in 15 to 20 minutes, taking the bricks up either one brick at a time, or several as desired. When doing this work by hand, the workmen were frequently obliged to break up several bricks, which were perfectly good, in order to get out one, so that the loss was considerable.

Removing Paving Brick with Sullivan Tools, Troy, N. Y.

*30 Church Street, New York, N. Y.

Before the purchase of this outfit, the cost of removing and cleaning bricks by hand was $24.00 per thousand, and a crew of ten men was able to handle about 1000 bricks per day. The detailed cost of operating the compressor and drill outfit in 1914 was as follows:

1 compressor engineer	$3.00
7 gallons of gasoline at 18 cents	1.26
4 operators at $1.85	7.40
Lubricating oil	.25
Total cost per day	$11.91

The above, of course, does not include interest or depreciation. Mr. Crowley estimates that about 2000 bricks are removed and cleaned in eight hours with

Cleaning Old Brick with Air Tools, Troy, N. Y.

the two tools, which are shown at work on these pages. This brings the cost of takingup and cleaning to $5.96 per thousand bricks. On work done with this outfit in 1914, a crew of 40 men was cut down to 18 men. It is estimated that this outfit pays for itself on every 100,000 bricks taken up and cleaned. Savings included labor on the brick, saving in the sand cushion, saving in time in making the bed under the brick and in laying the brick. Cement and grouting are also saved.

Mr. Crowley gives the following table showing the number of bricks cleaned each year and the saving made by the use of this outfit:

Year	Brick Cleaned	Saving
1913	229,000	$4,122.
1914	82,200	1,480.
1915	356,000	6,400.
1916	100,000 (Est.)	1,800.
Total,	767,200	$13,802.

The Sullivan portable compressor and hammer drills at Troy have been used by other city departments, including the water department, for cutting pipe trenches in rock and other light rock excavation.

Sullivan Portable Compressor, Troy, N. Y.

CAULKING PIPE JOINTS

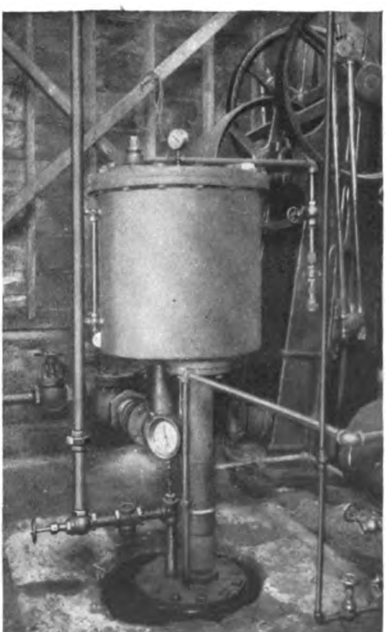
Another of the many uses to which portable air compressors can be put is that of operating pneumatic tools for caulking pipe joints. In 1915, the Burro Mountain Copper Company, Tyrone, N. M., employed a Sullivan 6x6 "WG-3" belt-driven air compressor mounted on skids and operated by an 8 h. p. gasoline engine for this kind of work. The tools used consisted of two Sullivan "DB-13" bushing tools with special caulking bits made locally. The compressor and engine were set at one point along the line of work until the air line was extended a distance of 500 feet, at which time the outfit was moved so as to catch up with the work. The air line consisted of ¾-inch pipe, and 80 lbs. pressure was maintained. The 12-inch main was laid in lengths of 10 to 15 feet and about 400 feet per day were laid and caulked. Each drill caulked from 15 to 20 of the

12-inch joints per day. Oakum and soft lead were used for caulking, due to the fact that the space between the joints was too small for lead wool. The foreman stated that 50 per cent more of pipe could have been laid per day if the trench ahead of them had been dug fast enough to permit that amount of pipe being laid.

SULLIVAN BOOSTER BOOSTS A WATER SUPPLY

By John Oliphant

One of the large, well equipped breweries of the New York City district is that of the Rubsam & Hormann Brewing Company, located in the Borough of Stapleton, Staten Island. At this plant, as in others in this district, the difficulty of securing an adequate supply has increased from year to year as the increasing number of wells and the demand for underground water have caused the normal water plane to recede from the surface. A number of wells have been drilled to different depths, and air lifts and deep well pumps installed in an effort to keep up the supply under the gradually increasing lift. Several shallow wells and one comparatively deep one were installed with the compressed air system several years ago at this brewery, but were expensive to pump and gave only a limited supply.



Sullivan Booster on the Well, with Discarded Deep Well Pump in Background.

Under these conditions the brewing company submitted its problem to the pneumatic pumping engineers of the Sullivan Machinery Company. The first effort made was to increase the production of a well located about 300 feet from the point of discharge and against an elevation of from 10 to 12 feet. A comparison of the results obtained by the old and by Sullivan well equipment under the same conditions of operation will be of interest. The compressor was the same in both cases (see first table).

It will be seen from these figures that double the amount of water was secured by the Sullivan installation, using 20 per cent less air, which in both cases was delivered to the same depth. The delivery from this well, with the new equipment, was then forced up to 150 gallons per minute, until other wells could be deepened and equipped. Upon another well much deeper than this one and located in the opposite corner of the property there had been installed a deep well power head and working barrel. This pump was using a 20 h. p. motor to its capacity to deliver 30 gallons per minute to a tank at an elevation of 80 feet. This equipment was removed and the Sullivan system installed, with the results shown

TEST OF WELL No. 1

	Old System	Sullivan System
Diameter, inches	8	8
Depth, feet	288	288
Depth of pump, feet	284	284
Diameter of discharge, inches	3	3 & 3½ standard pipe
Diameter of central air line, inches	1	1¼ standard air (outside)
Diameter of horizontal line, about 300 feet	3	24" booster & 3" pipe
Gallons per minute	50	100
Operating pressure at well, pounds	85	84
R. P. M. of compressor	50	40

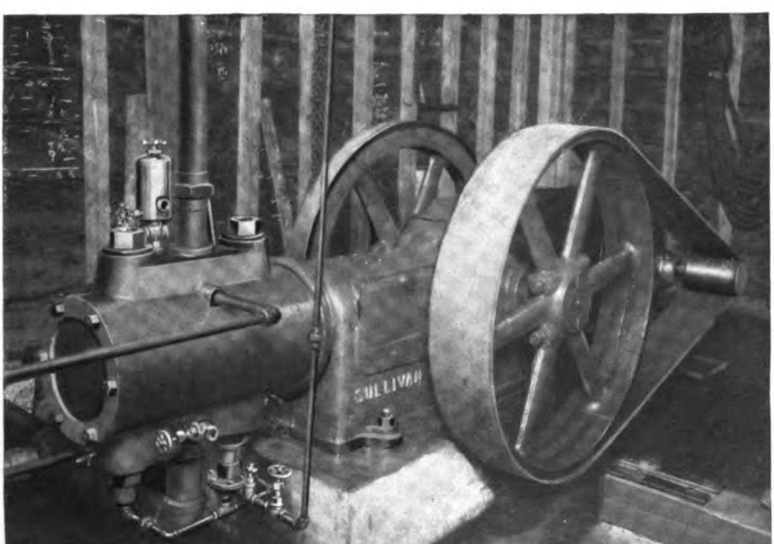
by the following tests. The motor was the same, and the speed and power were measured, in each case. The compressor is a Sullivan 8 x 8-inch class "WG-3," straight line, belt driven machine, with automatic lubrication, radial air valves and enclosed working parts.

Equipment.— The equipment consisted of one 8 x 8 "WG-3" air compressor, with pulley, 40 inches in diameter; one 22½-inch by 5-foot air receiver; one standard pump foot piece 2½ x 1¼ inch with well top 10 x 3½ x 1¼ inches; one cast-iron booster 24 x 24 inches, 3½-inch intake, 3-inch discharge; one 20 h. p. General Electric motor, 1000 r. p. m.. with six-inch pulley.

Piping in well.
137 feet 2½ inch standard pipe (eduction).
135 feet 3 inch standard pipe (eduction).
138 feet 3½-inch standard pipe (eduction).
410 feet 1¼-inch standard pipe (eduction).
5 feet discharge line booster to basin.

CONDITIONS OF TEST

Number of wells	1
Depth, feet	500
Diameter, inches	10
Static head, feet	60
Drop, feet	170
Elevation (including friction) feet	35
Depth of pump in well, ' eet	410



Sullivan " WG-3 " Air Compressor at Rubsam and Hormann Brewery. A Sullivan Angle Compound Compressor, belt driven, of 445-foot capacity has since been added to this plant

Starting submergence	350
Operating pressure upon receiver, pounds	89
Starting pressure, pounds	152
Operating pressure upon well, pounds	81
Shut-in pressure, pounds	78
Friction air pipe well, pounds	3
Revolutions of compressor	150
Piston displacement	69
Actual cubic feet of free air, (63¼ per cent volumetric efficiency)	43.64

Test of 20-H. P. General Electric Motor

Input H. P.	13¼
Output H. P	10¼
H. P. to belt wheel with 5 per cent belt loss	9¾
Delivering water to surface (see below)	"A"
Delivering water to basin with booster vent to atmosphere	"B"
Delivering water to basin with air from booster to riser pipe	"C"

	A	B	C
Gallons per minute	55	48	55
Total lift, feet	230	265	265
Submergence, feet	180	180	180
Percentage of submergence	44	40½	40½
Cubic feet free air per gallon	.793	.910	.793
Water horse power (theoretical)	3.2	3.21	3.69
Input efficiency per cent	24.4	24.2	27
B. H. P. efficiency per cent	33	33	38
Pressure on booster, pounds	...	15	7½

Rubsam and Hormann Brewery, Staten Island, N. Y.

RESULTS OF TEST

From this record, it will be found that with the booster, the same amount of water, 55 gallons per minute, was delivered to an elevation of 35 feet without increasing the power required to deliver it to the surface. Other wells are being deepened and equipped, and an abundant supply of pure, cold water has been secured, adding to the quality and quantity of the output.

DIAMOND DRILLING IN CORNWALL

The Sullivan Machinery Company, of Salisbury House, London, E. C., recently installed their diamond drills at the East Pool and Agar Mine in Cornwall. One machine, which has been in operation a few weeks, put in a bore of over 100 feet in a fortnight in very hard country. This is of great interest to the Cornish mining community, as there has been a good deal of scepticism about diamond drilling in Cornwall. It has thus been proved that the work can be carried out just as well in Cornwall as in any other part of the world, providing the proper machine and competent operators are obtained. There are indications that other Cornish mining companies will adopt the methods that Messrs. Bewick Moreing have been progressive enough to try.—*Iron & Coal Trades Review*, January 26, 1917.

OPERATING METHODS IN A STEEL SHARPENING SHOP

By James E. O'Rourke*

[The following article won the first prize offered by *Engineering News* for the best article on the subject indicated by the title. It appeared in *Engineering News* for Jan. 18, 1917, and was reprinted in *Engineering and Mining Journal* for Feb. 10, 1917. As printed below, it contains certain additions by the author. —Editor.]

Mining men are beginning to realize more clearly every day the need of a well equipped blacksmith shop for sharpening rock drill bits. When hammer water drills were adopted at the Wisconsin Zinc Company's mines near Platteville, Wisconsin, the management realized that hollow high-carbon drill steel required much greater care in handling than the solid steel which was formerly used with piston drills. Considerable thought was given this matter, and resulted in the erection of a new blacksmith shop at their Champion Mine. The site of this shop was carefully selected so as to be as nearly centrally located as possible in order to furnish steel to four mines, namely, the Champion, Longhorn, Thompson and Winskell.

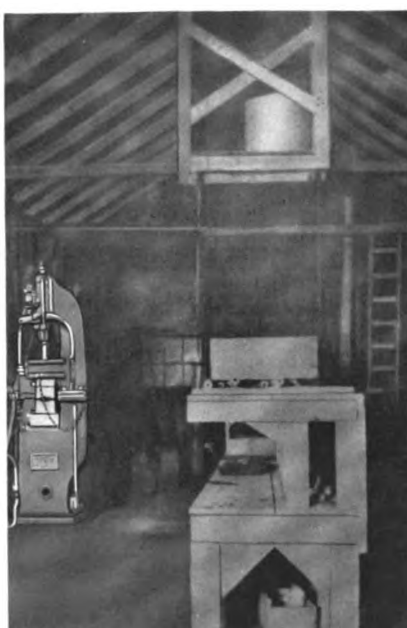
Appreciating the fact that four mines were liable to keep the blacksmith very busy, the writer endeavored to arrange the shop equipment in such a manner as to avoid all excessive handling of steel. With the idea of getting the greatest efficiency as regards the heating and also the making of drill bits and shanks it was decided to install a Denver Fire Clay Company's oil forge and a Sullivan Sharpener. See photo on this page.

LAYOUT OF THE SHOP

Attention is first called to the dull steel rack. This is illustrated by the photo, page 964 and also by section drawing, page 965. This is the rack for dull steel from the Champion Mine, whose shaft is located about fifty feet from the south end of the shop. When the dull steel is hoisted from the Champion shaft it is carried to the shop and each length is placed in the respective compartment allotted for it on the dull steel rack; naturally the longer lengths are placed in the lower compartments.

The movement of the steel through the shop from this point is as follows: From the dull steel rack it is placed on the upper deck of a double decked stand which is positioned in front of the oil forge as shown in plan drawing, page 965. This stand is also shown in the photograph below.

As originally planned the upper deck was about 1½ inches above the bottom of



Double-decked Stand for Steels, Wisconsin Zinc Co. Sullivan Sharpener in the Background

* Care of Granby Mining and Smelting Co., Granby, Mo.

Dull Drill Steel Rack

the fire opening in the oil forge; but we found later that it was necessary to place a protecting plate on top of the fire clay in the fire opening. The object of this protecting plate was to protect the fire clay body from damage resulting from dragging the bits in and out of the fire.

This plate was made of one-inch iron and in placing it at the mouth of the fire opening, the width of which was 3½ inches, it restricted the opening below the gauge of our starting bits, so it was necessary to place shims made of asbestos sheeting under the forge cap. Enough shims were used to bring the fire opening to a width of 3½ inches above the protecting plate.

The fire opening is of sufficient length to permit the placing of nine steels in the fire at once. The writer experimented with different forging heats and contrary to the recommendations of the steel manufacturer (namely 1500° F.) it was determined that the most satisfactory forging heat was close to 1650° F. A Wilson-Mauelen base metal pyrometer was used in indicating the various temperatures. The fire end of this pyrometer was held in position in the fire by means of a home-made attachment which was bolted to the forge cap.

Colonial steel was used, an analysis of which is as follows:

Component	Per Cent
Carbon	0.88
Manganese	0.35
Phosphorus	0.011
Sulphur	0.017
Scleroscope hardness	.44

The blacksmith stands on the sharpener side of the double-decked stand with his helper on the opposite side. The smith takes a heated steel from the side of the forge nearest him and one step backward places him in position to operate the sharpener. The dressing of a bit requires about thirty seconds; however the writer has often witnessed the completion of this operation in twenty seconds. Much valuable time is saved by placing the finished bit on the lower deck of the double decked stand instead of the old haphazard way of throwing it on the ground where it will be in the way and must be picked up later.

When the blacksmith places a finished bit on the lower deck, which operation is performed by a slight bending motion, he is in position to take another heated steel from the forge and the dressing operation is repeated. It will be noted that he performs his operations with a minimum of bodily effort.

TEMPERING THE BITS

In the meantime, the bits previously sharpened have had time to cool to a dark color and are ready for the tempering heat. The writer is very well aware of

the efficiency of an intermediate or refining heat to remove forging strains previous to tempering, but owing to the heavy steel demand and the fact that satisfactory results were obtained with two heats, it was decided to dispense with the refining heat.

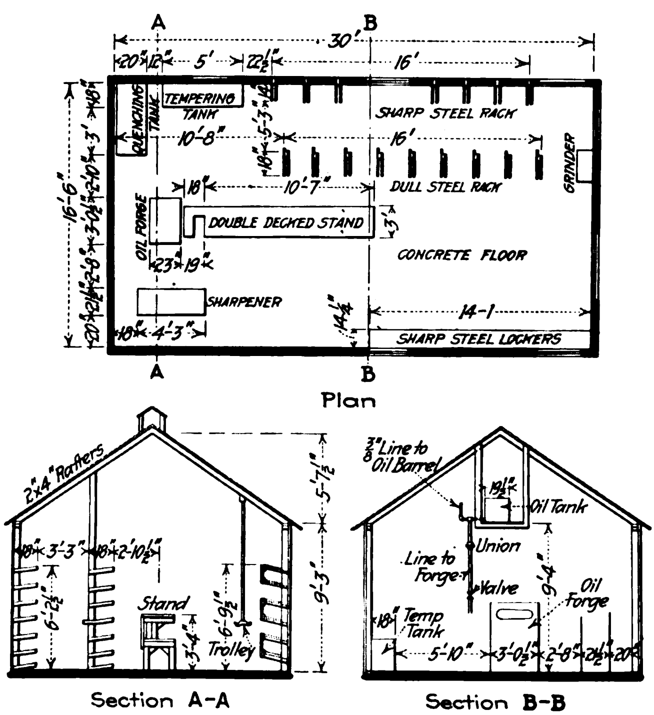
While the blacksmith is adjusting the temperature of the forge for the tempering heat, namely about 1470° F., the helper is removing the cooled bits from the lower to upper deck, after which he resumes his first position. Standing here he inserts bits in the forge and heats them to the above mentioned temperature. Two methods of tempering were practiced. One was to lower the temperature by partly quenching and then drawing the temper to the desired color. The other method consisted of plunging bits in a brine, sal ammoniac, saltpeter and bromide of potash solution, covered with about six inches of Houghton's No. 2 soluble quenching oil, the bit not being withdrawn until thoroughly cooled.

Page 967 shows details of the tempering tank in which the above tempering solution was placed.

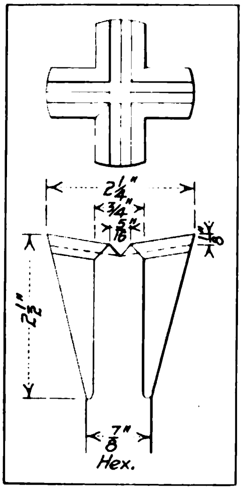
It is well known that brine as a tempering agent causes much faster contraction of the molecules than water, which contraction sometimes has a disastrous effect on the bit when drilling in lime rock; however, this rapid contraction was somewhat retarded by a protecting film of oil. The bromide of potash has the property of offsetting any injurious effects sustained in case of overheating. The other ingredients of the solution were added to soften and purify the water.

After the steels were thoroughly cooled they were removed from the tempering tank and placed on the adjacent sharp steel rack with the shanks in the direction of the grinder shown near the door of shop, (see sketch below).

The final operation consists in grinding the ends of the shanks perfectly true and square. This work is done by a No. 2 Willey direct connected bench grinder (Jas. Clark, Jr. Electric Co., Louisville, Ky.) equipped with 12-inch wheels. This grinder is located on a line with the rear end of the dull steel rack. A grinder strap is provided at just the right height



Details of the Drill Sharpening Shop, Wisconsin Zinc Company, Platteville, Wis.



Details of Double Cross Bit

to bring the center of a ⅞-inch steel immediately opposite the center of the wheel. The grinding operation is performed by merely rolling the steel on the grinder strap, which holds it in perfect alignment with the emery wheel, thus providing a good square shank. The rack and grinder strap are shown in the photo, page 964. After the shanks are ground the steels are replaced on the sharp steel rack, whence they are carried to the collar of the Champion Shaft.

SORTING THE STEELS

Any mine operator who has ever tried to sharpen steels for two or more mines in one blacksmith shop will appreciate the fact that it will be a matter of only a few days before one mine will have absorbed most of the steel, unless some steps are taken to prevent it. In order to provide against this contingency three double racks were erected along one side of the building.

One each of these sets of racks is open to receive the dull steel when it is brought from its respective mine. The other is protected by a wooden grating which is furnished with hinges and a lock. These locked compartments contain the sharp steel. A sufficient amount of steel is provided for each mine so that when a load of dull steel is delivered to the shop it is counted and an equal amount of sharp steel is taken from the closed rack and returned to the mine, after which the dull steel is sharpened, and placed in the closed rack under lock and key, awaiting tomorrow's demand. It can be readily seen that if the above system is religiously observed by the blacksmith, it will be easily possible to keep an exact cost of the steel sharpening for each mine, likewise the relative steel consumption.

FUEL OIL SUPPLY

As originally planned, oil for the forge was provided by gravity flow from an overhead tank holding 22 gallons, which was supported on a frame hung from the timbers. The pipe leading from this tank and the tank itself are shown in the sketch on the following page. The main supply of oil is carried in a shed adjoining the shop. A rack that will hold a dozen barrels is provided, with steam pipes running under it so that the oil is kept at the proper temperature and ready for service. A hand pump is used to force the oil from the barrels up to the tank.

Owing to objections raised by the underwriters against the gravity system it was necessary to place an oil pressure tank outside the building as shown on page 967. This materially lessened the fire risk. The oil in this case is heated to proper temperature by means of a coil placed in a stove, water being furnished to this coil from the mine pump discharge column and circulated through the hot water jacket around the oil pressure tank, thence to the upper barrel in which an oil reservoir tank is placed. In this manner a storage of about 50 gallons of warm oil is constantly provided. The fuel oil used is 17° Baumé at 60° F. and contains a calorific content of approximately 18,500 B. T. U. per pound.

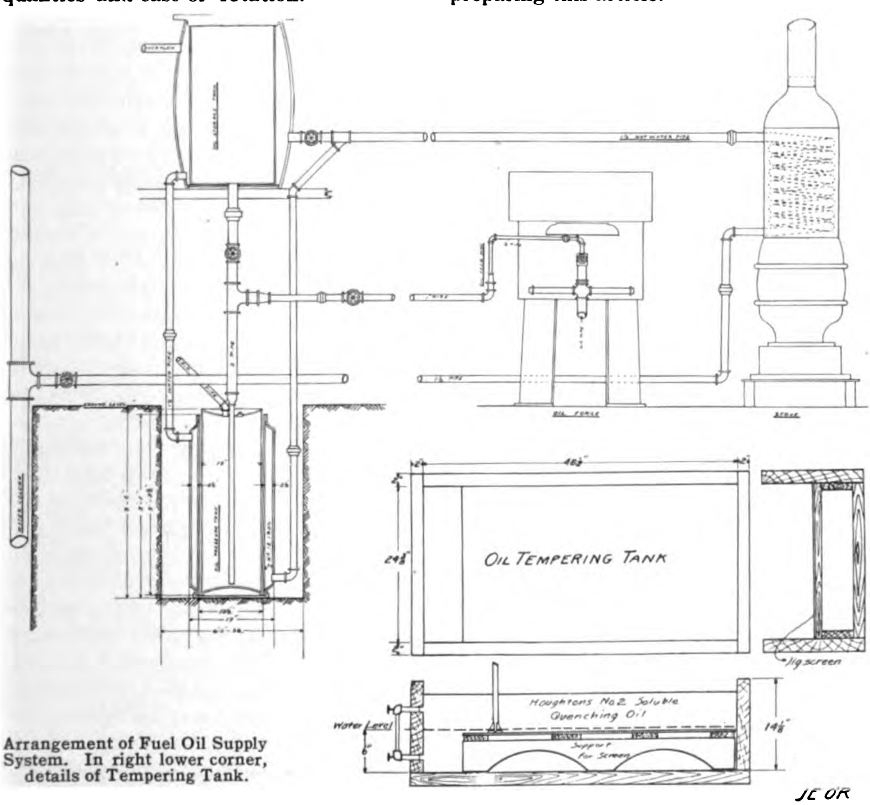
Another kink consists of a trolley for supporting the drill steel in the sharpener. A rail similar to a barn door hanger is attached to the roof framing and carries two roller bearing wheels in tandem with a hanger between them from which is suspended a rod about nine feet long. The end of this rod is threaded to hold a double swivel hanger which can be adjusted instantly as to height. On this the drill steel rests during the sharpening operation. Longer or shorter steels can be handled by running the trolley along its track. This eliminates the usual tripod steel support.

The type of drill bit used is shown on page 966, and for various reasons is most applicable for drilling Wisconsin limestone when used in connection with hammer drills, on account of its high penetrating qualities and ease of rotation.

An estimate of the cost of the above shop with complete equipment as herein described, including the building, is approximately $2300.00.

The results obtained with this installation have been very gratifying and have effected a material saving in cost of steel sharpening as well as increased efficiency of the drill bits. The latter is really the most important consideration, as the entire ground-breaking cost pivots directly on the business end of the drill steel, namely the bit.

The writer is greatly indebted to Mr. Douglas C. Corner, former superintendent of the Champion Mine (now member of the Engineering Staff of American Zinc, Lead and Smelting Company, Granby, Missouri) for his kind assistance in preparing this article.



Arrangement of Fuel Oil Supply System. In right lower corner, details of Tempering Tank.

DEEPEST DIAMOND DRILL HOLE IN AMERICA

The accompanying photograph shows a Sullivan diamond core drilling outfit, with which was drilled the deepest diamond drill hole in North America. This hole which was completed at a depth of 4920 feet, was drilled in Sussex County, N. J., in 1915 and 1916 on the properties of the Sussex Calcite Company, the mineral sought being zinc.

This hole, nearly a mile in depth, exceeds by about 1700 feet the deepest hole, hitherto put down on the North American continent, of which records are available. The work was done by the Contract Drilling forces of the Sullivan Machinery Company, with a Sullivan Class P heavy duty drill, operated by a 30 h. p. portable steam boiler. The derrick shown in the picture was made of timbers and was 55 feet in height. The drilling was carried on over a period of 20 months. Drilling was started with class "N" fittings, removing a core two inches in diameter. At a depth of 1500 feet, the fittings were reduced to size "B," removing a 1⅜-inch core, and this size of tools was maintained until the completion of the hole.

Sullivan "P" Diamond Drill and Derrick over 4900-foot Hole in New Jersey.

A core barrel 10 feet in length was used and the customary ten-foot drill rods were employed. But, in order to facilitate speed in handling the rods, joints were broken every thirty feet. Work was carried on in two 10-hour shifts. The crew consisted of a drill foreman who did the diamond setting, and superintended the work; two drill runners (one for each shift), four helpers, and two firemen.

When the final depth was reached, the time necessary for hoisting out the long line of rods, and for lowering them again to resume drilling, amounted to 8 hours. The weight of the long line of rods required for this drilling, at 4900 feet, was 13 tons. In hoisting, these rods were handled by the hoisting engine and drum

forming a regular part of the drill equipment. A ⅞-inch steel cable was used for handling the rods, running over two sheaves, a three-foot running sheave and a four-foot stationary sheave at the top of the derrick. The hole bored was true and straight, showing no deviation from the perpendicular.

As noted in the October, 1916, MINE AND QUARRY, only three or four diamond drill holes are recorded in North America which have reached a depth as great as 3000 feet. One of these was bored in the Warren district of Arizona, to a depth of 3200 feet, one in Alberta to a depth of about 3000 feet and two others in Northern Michigan to approximately the same depth. All of these holes were put down with Sullivan drills.

HETCH-HETCHY DIAMOND DRILL BORINGS

One of the biggest pieces of construction in process in the far West is the Hetch-Hetchy Aqueduct, which is to supply San Francisco with water from the Hetch-Hetchy Valley when completed. Over $43,000,000 has been appropriated for this work.

In order to determine the exact nature of the ground in which the aqueduct is to be constructed, considerable test boring work is being carried on by means of diamond drills.

Near Chinese Camp, Calif., some very effective work is being done with Sullivan class "H-2" diamond drills. On the 10th of December, 1916, an "H-2" machine was put in operation. By the 31st of December 800 feet of hole had been drilled in granite, removing cores 15/16-inch in diameter. Another "H-2" machine was started on the 9th of December. This had drilled 900 feet of hole by the 31st. Both machines were operated three shifts. Most of the drilling was done in granite with a shallow capping of slate. The above drilling consisted of one hole of 800 and one of 900 feet in depth. Ten-foot core barrels are used, and solid cores have been removed up to 9 feet 6 inches in length, as shown by the accompanying photograph.

Cores Removed by Sullivan Diamond Drills on the Hetch-Hetchy Valley Aqueduct, California

NEW PUBLICATIONS

AIR LIFT PUMPING. Bulletin "71-C," Sullivan Machinery Company, 36 pages; describes improved methods of lifting water by air power with especial reference to high efficiency. Contains numerous illustrations of modern foot pieces, booster separators, acid pumps, and of installations; also reference tables.

Sullivan Channeler Cutting the Walls of the Balmain Reservoir, Sydney, New South Wales

CHANNELING AN AUSTRALIAN RESERVOIR

BY ALLISON WALKER*

In order to increase the water supply of Balmain, a large suburb of Sydney, New South Wales, the Sydney Metropolitan Board of Water Supply and Sewerage decided to place a storage tank at the highest point attainable in the suburb. This point fortunately happened to be in Gladstone Park, and since the rock underlying that section of the country is a soft sandstone, it was decided to dig up a portion of one end of the park, and put in a storage tank 180 feet long, 80 feet wide and 30 feet deep with a capacity of two and one-fourth million gallons.

The park, being in the center of a thickly populated district, is used very extensively, and none of the ground could be spared permanently, so from the start it was understood that the tank when finished was to be covered over and the ground used as before by pleasure seeking people. The top of the tank is of cement, and is covered with about two feet of soil. Concrete pillars, reinforced by built-up steel columns and spaced equally twelve feet either way, hold up the top of the tank. Heavy steel girders connect the top of the columns and hold the wire netting, which in turn has been imbedded in several inches of concrete, thus forming the roof. (See cut on page 971.)

Because of the restricted area to work on and also because of the proximity of a hospital, no explosives could be used in excavation.

Several different methods were suggested for removing the rock, but it was finally decided to channel the walls and remove the interior by breaking the rock up in small pieces by the plug and feather process. A Sullivan "VX-21" channeling machine and a Sullivan 12 x 12 x 12 "WA-4" single stage, steam driven air compressor were purchased to do the work.

The "VX-21" channeler has a cutting engine 4½ inches in diameter, and is operated by compressed air. The feed engine which drives the channeler along the track is also operated by air. A

*310 S. Frisco St., Tulsa, Okla.

Roof Framing and Supports, Balmain Reservoir

special rolling valve is placed in the exhaust port, so that the blow may be cushioned. This prevents damage to the lower head in case a mud seam or other irregularity in the rock is encountered. Because of this and also because of its simplicity, ease of operation and lightness the "VX-21" proved to be just the machine for this class of work.

A cut eleven feet six inches deep was taken through the center of the tank, and the rock was broken to this free edge from either side. The walls were next channeled, and with a 23-foot section of track, runs of 170 to 180 square feet per eight hours were very common.

When first planned it was decided to line the tank with a six-inch cement wall, but the channeled walls are so straight and in such good condition that the cement wall was obviated, and a cement gun used to stop up the few cracks and crevices, and to give the tank a thin coating of concrete. The saving in the cement wall itself is a big item, to say nothing of the increased speed of construction by the use of the Sullivan Channeler.

Another channeled job on which the "VX-21" has been used with profit is shown by the photograph on page 972. This is a dry-dock at Sydney, Australia, which has been excavated from the solid rock. The use of channelers obviated blasting the walls, with its attendant shattering and irregularity. The photograph was taken from a ship in the dock.

Sullivan Channeler and Second Wall Cut, Balmain Reservoir

Sullivan Channeler and its Work in Enlarging an Australian Dry Dock, taken from a Ship in the Dock

AIR POWER IN THE NAVY

Compressed air plays an important part in the firing of the big guns on our battle ships. All "powder-bag" guns (using non-fixed ammunition) are equipped with compressed air jets, which automatically blow the gun clear of gases and burning bits of powder bags, so that when the breech is opened, the bore is clean and the old danger of a flare-back, with its disastrous results, is entirely removed.

The use of high pressure air for discharging and operating torpedoes is no doubt familiar to our readers.

In some vessels, air performs another useful service, in closing the water-tight doors. By throwing a lever on the bridge, or in the conning tower, all the water-tight compartments can be instantly closed, in case of a collision or other accident to the hull.

THE CASTELLETTO MINE

From Our Turin, Italy, Correspondent

The mountain fighting on the Italian front presents terrific natural difficulties and calls for the exercise of great engineering ability, in addition to the other more usual military characteristics. It is one thing to dig trenches and drive mine galleries under the enemy in earth, and quite another to carry on the same operations where rock is the material encountered. The mountainous Italian front is networked with roadways, trenches, chambers, lookout stations and galleries cut from the solid rock in order to give protection to one side and to annoy the other. A pamphlet in Italian, received some time ago by MINE AND QUARRY, describes one of the most pretentious of the numerous mines which have been driven, namely, the Castelletto Mine, and this enterprise holds particular interest for American readers because American drills and compressors were employed, as, indeed, they are being employed at many points along the front, to carry on this work expeditiously.

This work was executed by the Fifth Alpini Division of the Fourth Army Corps, and was undertaken after four or five different attempts to dislodge the Austrians from a very strong position on the Castelletto, which is a projecting shoulder of Mount Tofana. This afforded to the Austrians a base for attacks which practically cut the Costeana Valley in two, requiring the Italians to transport materials and move troops entirely by night and with great difficulty. Beginning January 3, 1916, six and one-half months were required to carry out the mining enterprise. Positions were first selected and carefully fortified as near the objective point as possible. Living quarters were constructed for the soldiers and working crews and emplacements established for the artillery, as all of this work had to be carried out under constant artillery fire

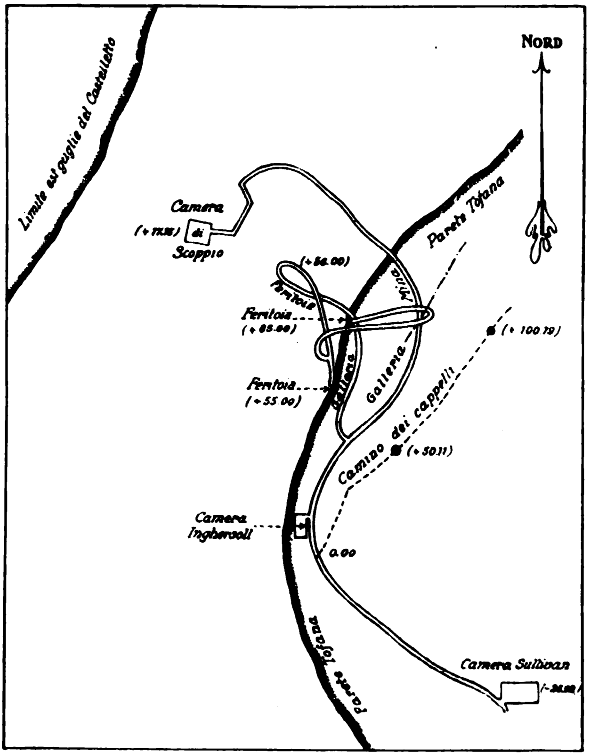
and in danger from bombs and other explosives. Counter-mines were also driven by the enemy in an effort to nullify the work of theItalians.

Following this preliminary work, in which 660 cubic meters of rock were removed, a series of elaborate and accurate surveys were made, from which topographical reliefs were drawn, distances accurately calculated and the course and destination of the proposed tunnel mapped out. Preliminary drilling work was carried on by hand up to the end of March and the results secured were very slow. At that time, however, an underground station was completed and the machinery placed in position. Mechanical drilling was started on April 2 with two outfits, both of American manufacture. The larger of these consisted of a Sullivan air compressor of the class "WG-3" pattern, placed on a concrete foundation at the entrance to the tunnel and operated by belt from an Aquila oil engine of 30 horse power.

Some distance farther on in the tunnel, a second station was cut for a smaller American belt-driven compressor and gasoline engine of another make. These two compressors supplied compressed air at about 100 pounds pressure to their receivers, from which the air was conducted by pipe and hose lines to the hammer drills. These were of two American types, including several 40-pound Sullivan hand hammer drills and one Sullivan stoper for drilling holes over 45 degrees from horizontal.

The work was carried on in four shifts of six hours each, the crews con-

Sullivan "WK-3" Portable Air Compressors in an Italian Army Barracks, Ready to Leave for the Mountains



Plan of the Castelletto Mine. Scale 1—1000

proper; loop hole galleries 162 meters in length, side galleries and emplacements for mountain guns; an adit for wasting the material as above described, 136 meters in length, the tunnel or gallery proper and the mine chamber, where the explosives were finally placed. This aggregated 2200 cubic meters of solid rock excavation.

Owing to the contour of the ground, the tunnel was obliged to take a deviating instead of a direct course and was carried upward at a varying grade averaging from 36 to 39 per cent. The mine chamber was 100 or more feet higher than the starting point of the tunnel. When the objective point originally selected had been reached it was found that the enemy had retreated from their original location, so that it was necessary to turn the course of the tunnel and to drive it a considerable distance farther in order to be directly beneath the enemy forces and their defense work. The explosive employed for the final blast consisted of blasting gelatine mixed with 92 per cent of nitroglycerine, and the total charge amounted to 35 tons. In all, seventeen electric circuits were employed to secure proper distribution of the blast and these were divided into three groups, two being composed of six circuits each. The cartridges or loads were made up of alternate layers of gelatine and guncotton and contained a picric acid exploder ending in a guncotton cartridge, with an electric cap.

In order to confine the effects of the explosion a heavy barricade was constructed

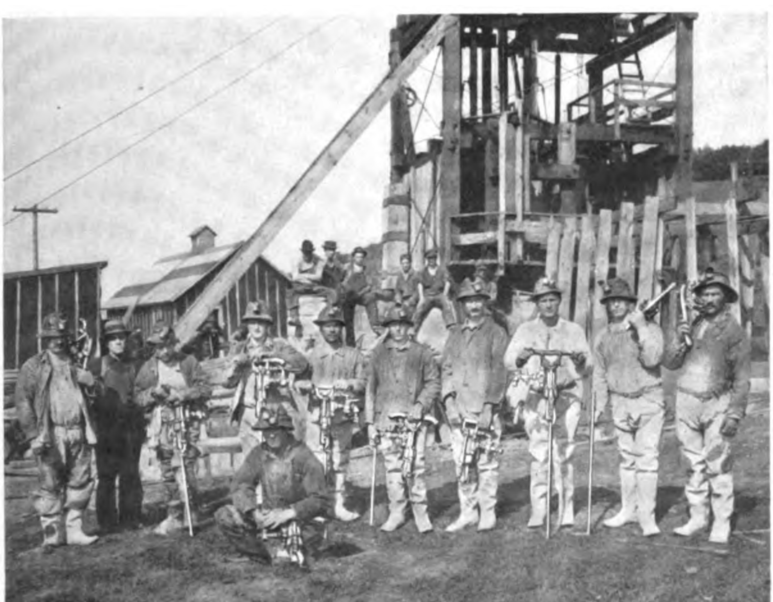
sisting of a foreman and twenty-five to thirty miners. The size of the tunnel varied from 6x6 feet to 6½x6½ feet. Military blasting gelatine was employed during the early part of the work, but was replaced later by grade A-1 dynamite gelatine. The drill holes were heavily loaded in order to break up the muck small, to permit rapid handling. The muck was loaded in small mine cars running on Decauvilles rails and was wasted down the side of the mountain through a side gallery. The average progress of the tunnel, or that section of it driven with the Sullivan equipment, ranged from 16 to 20 feet per 24 hours. The total amount of excavation included a passageway 250 meters long, leading from the living quarters to the tunnel

in the tunnel behind the chamber, composed of concrete and sacks of earth, reinforced by heavy wooden beams. Three right-angle turns, made for the purpose near the mine chamber, also aided in this effect. The theoretical length of this barricade was 26 meters, but as the mine was developed, it was actually 33 meters, of which 21 consisted of concrete and 12 of earth and timbers. The loading of the explosives began on July 3 at 17 o'clock, and all of the electric connections were completed and sealed by July 9 at 15 o'clock. The mine was exploded July 11 at 3:30 and from the standpoint of its builders was a complete success, as to the result of the calculations made, as well as to its practical effect.

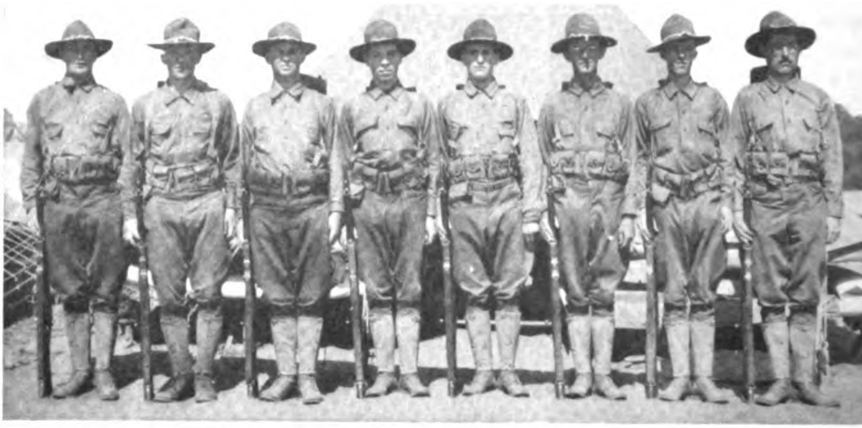
MICHIGAN MINE SHAFTS

The accompanying photograph was taken several months ago at the Holmes Shaft of the Cleveland Cliffs Iron Company, Negaunee, Michigan, and shows the drilling crew and equipment, consisting of ten Sullivan Rotators, with which this shaft was recently completed to a depth of 1250 feet.

Readers of MINE AND QUARRY will recall that record work was done with machines of this make and type at the Woodbury Shaft of the Newport Mining Company, Ironwood, Michigan; which was completed just about a year ago to a depth of 2300 feet. The size of this shaft was 21x13 feet and it was completed in 12 months' time. During the last eight months the shaft was entirely in granite, and during this time the Sullivan drills, ten of them, were used exclusively. Other large size shafts in the iron and copper country of northern Michigan put down during the past two years with Sullivan Rotators



Sullivan "Rotators" and Drilling Crew at the Holmes Shaft, Cleveland Cliffs Iron Company, Ishpeming, Michigan

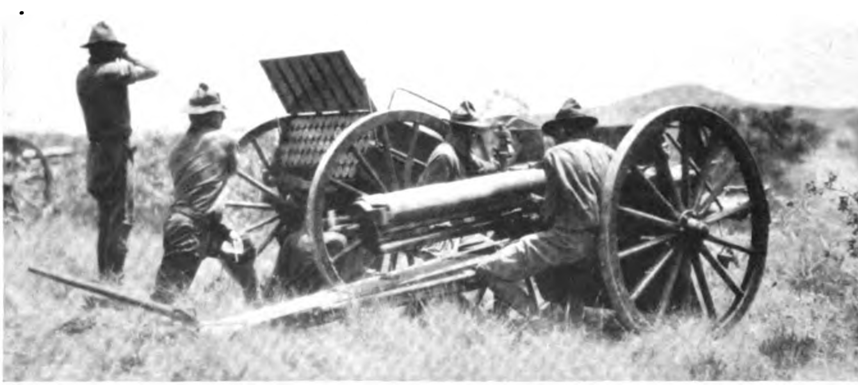


Citizen Soldiers at Plattsburg, N. Y.; Corporal J. A. Noyes, at Right, is the Sullivan Machinery Company's Representative at Des Moines, Iowa

include the Athens Shaft, Negaunee, the Yale Shaft, Bessemer, the Mackinaw-Gardiner Shaft, Gwinn, Michigan, the White Pine Extension Shaft at Ontonagon, Mich., the Spies Shaft at Iron River, and the Ironton Shaft at Bessemer.

"SULLIVAN" FOR PREPAREDNESS

The accompanying snap-shots demonstrate that the Sullivan Machinery Company believes in national preparedness. Its president, Mr. Frederick K. Copeland, has served as chairman of the Illinois State Commission on Industrial Preparedness. Not only did some hundreds of its Chicago employes and officers march in the great preparedness parade last June, but a goodly number re-



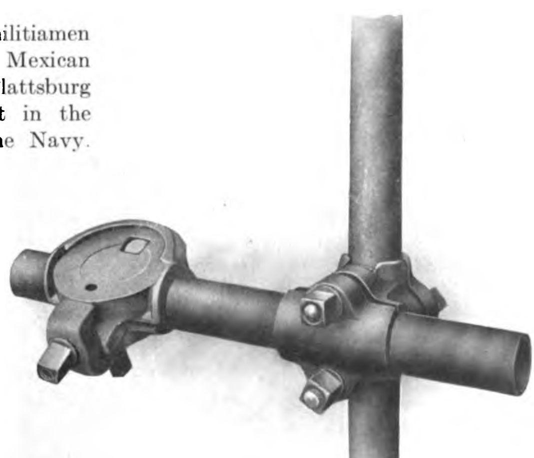
Battery "C," First Illinois Field Artillery at Target Practice, Leon Springs, Texas. The Assistant Editor of Mine and Quarry Belonged to this Battery

Civilian Tars Scrubbing Decks at 5:30 A.M. on the Battleship "Louisiana." "New Jersey" on the Port Bow. (Photo by Editor, Mine and Quarry.)

sponded to the call as state militiamen and saw active service on the Mexican border. Others attended the Plattsburg training camps and took part in the civilian volunteer cruise of the Navy.

ADJUSTABLE COLUMN ARMS

The adjustable extension arm for mining columns or shaft bars, shown in the accompanying cut, is a recent innovation of great convenience for various classes of mining work. The arm portion of the mounting consists of an ordinary piece of pipe and a double clamp. One member of this clamp grips the bar or column, while a second or rear clamp is provided to hold the arm. By loosening two bolts, arm can be slipped through the clamp so as to leave any desired length projecting. When driving a tunnel the arm can be slid out so as to get the drill as close to the wall as possible for drilling either cut or rib holes. If a tunnel is being driven with an arched roof, the arm can be raised to the top of the column and shifted in so as to permit roof holes to be driven at just the desired points, and then, without moving the column, the drill and arm can be lowered and the arm extended close to the rib again for the rib holes and lifters. This mounting is found convenient also for use in connection with the light hammer drills now in use, for slicing and slabbing work, or when it is desired to put the column in the center of a narrow drift, and drill up the entire round without changing its position. The extension feature of the arm in such cases is very valuable. Arms up to 42 inches long can be used on the light 2½-inch column, suitable for the Sullivan Rotator hammer drills, with cradle mounting or pneumatic feed mounting.



Extension Arm and Special Clamp

MINE AND QVARRY

REG. U. S. PAT. OFF

VOL. X, No. 2 AUGUST, 1917 WHOLE No. 33

Preparing for Evening Colors, U. S. Battleship "Louisiana"

DRILL BITS AND STEEL

AN EAST INDIAN TIN MINE

TURBINAIR COAL CUTTERS

PVBLISHED BY THE SVLLIVAN MACHINERY CO.

TABLE OF CONTENTS

MINE AND QUARRY
REG. U. S. PAT. OFF.

VOL. X, No. 2 | AUGUST, 1917 | Whole No. 33

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.
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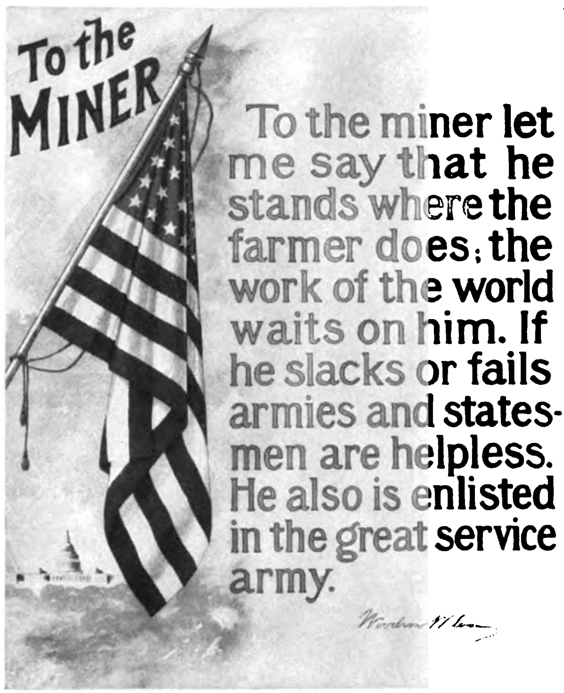
In this issue will be found a list, already incomplete, of employes of the Sullivan Machinery Company who have joined the colors in one or another capacity; among them, the former manager of the Company's London office, Mr. Hoy; the manager of its Denver, Colorado, office, Mr. Blackinton; the assistant editor of MINE AND QUARRY, Mr. Greeley, and others. Nearly all of the company's sales offices, and, needless to say, both of of its factories are represented in the Roll of Honor.



[A poster from the Department of the Interior, Franklin K. Lane, Secretary]

The importance of Mr. G. H. Gilman's paper on "Drill Bits and Drill Steel," the first section of which is printed in this issue, should not be overlooked by any users of drills and drill steel.

The "business end" of mining is the drill bit, and as pointed out by Mr. Gilman, too little attention has been paid to the bit, while thousands of dollars have been expended in testing drills to determine the proper machines for the conditions met. There have been many reasons for this neglect, and some of them correspond to the neglect with which the hammer drill was met upon its introduction.

Wrong as it has been, the idea, in a majority of cases, was to stick a piece of steel in the chuck and "let her ramble."

The author of the article in question has proven by actual tests running over long periods of time, with many recheckings, that results never before thought possible can be accomplished with the proper care and attention to drill bits.

Briefly listed, he has demonstrated the fundamentals as follows.

1. *Quality of steel.*
2. *Shape of bits.*
   a. *Angle of cutting edge.*
   b. *Shape of cutting edge.*
   c. *Amount of cutting edge.*
   d. *Amount of reaming edge.*
   e. *Length of reaming edge.*
3. *Heat treatment.*

The buying of hollow steel on rigid specifications as to carbon contents and size of hole, has proven that the steel of higher cost is not the most expensive to use.

However, there still remain many mine executives who refuse to recognize the wisdom of buying steel of the best quality.

Mr. Gilman has shown to the satisfaction of those familiar with his research that a proper shape and proportioning of an ideal bit has been achieved by these experiments.

In determining these points the experiments were conducted along lines to determine the length of cutting edge, its angle, its susceptibility to proper heat treatment, and probably the most important of all, its reaming quality as governed by the proper proportioning of bearing and reaming surfaces.

He has determined that the reaming qualities of a bit, taking into account factors of clearance, bearing surface and reaming surface as applied to different conditions met, are even more important that the cutting edges in the average case.

The development of a bit which can be tempered to the best advantage was also an important object, involving the matter of even heat throughout the bit, owing to its shape and proportioning of stock, at the same time keeping in mind the earlier points of cutting and reaming capacities.

Knowing that drilling speed varies as the square of the diameter of the hole being drilled, Mr. Gilman set out to find a bit which would give the maximum penetration before being rendered inoperative by reason of loss of gauge, as well as dulling of cutting edge.

From the vast number of careful tests conducted the indications point strongly to the conclusion that the double arc bit most nearly meets the ideal of drill bit design.

Certainly the fact that the double arc bit drills some four times as far, at equal or greater speed than the perfectly formed cross bit, with one-quarter of the loss of gauge, will be a matter of surprise to many experienced miners.

Regardless of prejudice toward "something new," the drill user who will have the patience and foresight to follow up Mr. Gilman's experiments will be rewarded by results under most conditions.

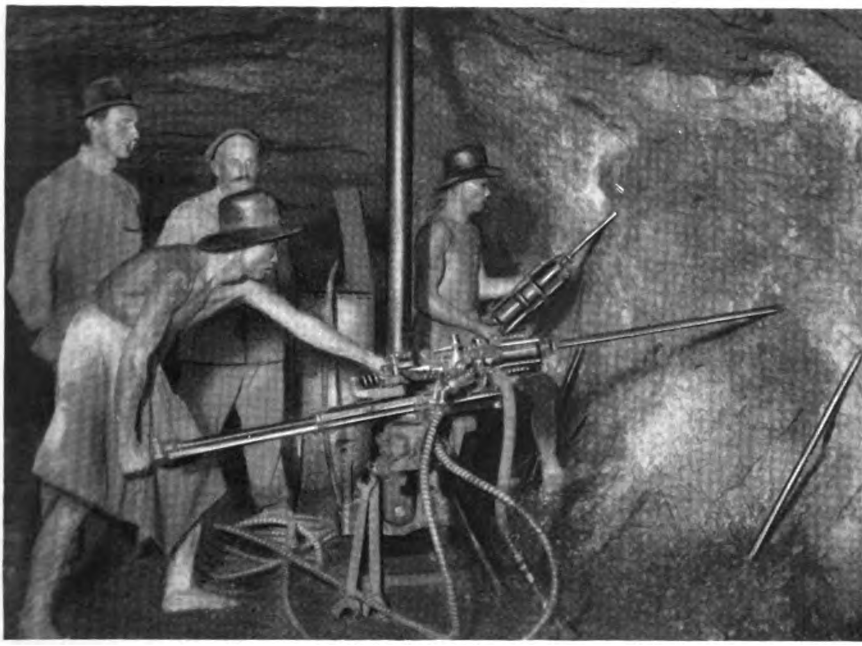
Readers of MINE AND QUARRY are cordially invited to inspect the Sullivan Machinery Company's exhibit at the Annual Foundry Show of the American Foundrymen's Association, which will be held in Mechanics' Hall, Boston, from September 25th to September 29th. The Sullivan exhibit will be found in spaces 301 and 302, in the Foundry Machinery Section. It will consist of a 445-foot Sullivan angle-compound air compressor, short belt-connected to a 75-h.p. motor; of a Sullivan Class WG-3, belt driven, single stage compressor; and of an exhibit of Sullivan air lift pumps and booster. The angle compound compressor, which will be fitted with the new Sullivan plate valves, will be in operation continuously during the exhibit, and will supply air to operating exhibits in the Foundry and Machine Tool Sections. The Foundry Show is one of the most interesting and "live" mechanical exhibits of the year and is well worth a visit, even from those not directly connected with the foundry industry.

The San Francisco office of the Sullivan Machinery Company has changed its location from the Sheldon Building, 461 Market Street, to the Hobart Building, No. 582 Market Street. Mr. R. P. McGrath is manager.

AN EAST INDIAN TIN MINE

Written especially for MINE AND QUARRY

By C. W. A. LELY, Mining Engineer*



Sullivan Water Tube Rotator drifting on a Cradle-Mounting, at the Tikoes Mine, Billiton, D. E. I. A Hand Rotator is in use in the background.

On the isle of Billiton, Dutch East Indies, in the district of Sidjoek, a large ore body occurs, consisting of two different types, namely, irregular shaped lenses of quartz bearing large crystals of tin and wolfram ore, the whole being included in "greisen," which contains a uniform percentage of fine cassiterite and some tungsten.

This deposit is being worked by the Tikoes Mine. In former days, the richest parts of it were mined by Chinese to a depth of ninety feet by open-cut work. All drilling was done by hand, the holes being blasted by a safety explosive, which was supplied by the Billiton Company, to whom the ore was sold, and the tin and wolfram were separated by hand-sorting under the company's supervision, and sold at Singapore. The mixed "fines" were also shipped to the Malay States and sold to a magnetic separator plant, until the company installed a magnetic separator on its own account in the year 1909.

The company then took over the exploration work, to ascertain whether the Tikoes Mine contained sufficient values to allow of the erection of a modern mill. A rectangular shaft was sunk in the surrounding granite at a distance of about 100 meters from the quartz pit, which is now 350 feet deep. While hand drilling was employed to start with, a machine-drilling plant was ordered, consisting of a Sullivan air compressor, class "WJ," of the cross compound, belted type, driven

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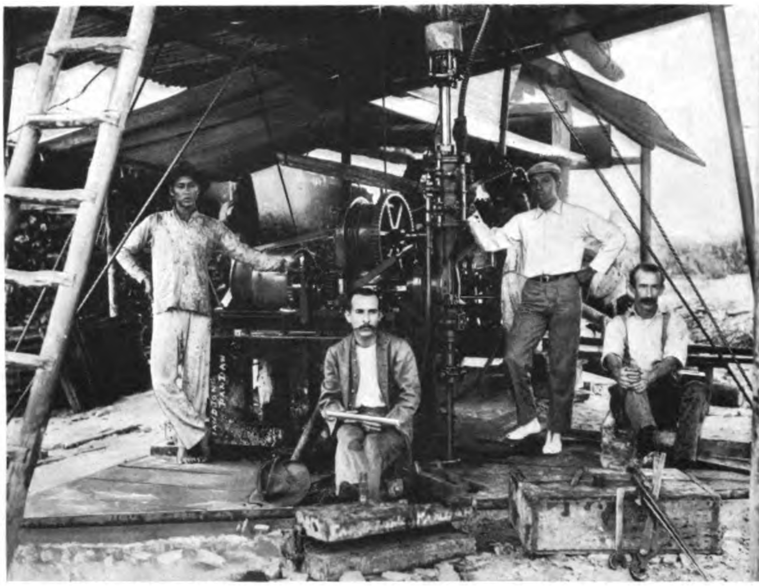


Sullivan Diamond Drill, prospecting for tin on property of the Billiton Company, Dutch East Indies.

by a 60 h. p. Diesel engine, and some "D-15," "D-19," and "D-21" Sullivan hammer drills, which were later on replaced by the newer "DB-15," "DB-19," and "DA-21" drills, which are still in use. The shaft was sunk entirely by hand drills. As tunneling began, piston drills were tried, but they proved impractical because of the frequent pinching of the drill steel, due to rapid wear of the sides (gauge) of the bits in the very hard ore. So tunneling was done entirely by means of the above named hammer-drills, which met with much more favor among the Chinese laborers than did the heavy piston-drills.

SHAFT RAISING WITH STOPERS

The "DA-21" stoper is the most efficient drill thus far used for boring upward holes, its drilling speed being more than one inch per minute, including the time for cleaning the holes, changing drill steels and shifting the drill from place to place. In the center of the ore body a second shaft was raised solely by the aid of these machines, as well as a good many raises between the levels. The "DB-15" and "DB-19" drills do about the same work, the "DB-15" machine being the more economical of the two, as it uses ⅞ inch drill steel against the "DB-19" machine's one-inch, while the wear of steel per foot bored is the same for both sizes.

The mine has been developed to a depth of 350 feet and three levels opened up, on each of which a good deal of driving had to be done, some 6000 feet in all. As the ore proved richer at depth it was decided last year to extend the works considerably; a new power house was built (page 981) in which were installed a 450 h.p. Wolff locomobile, driving a large generator and a new Sullivan angle-compound air compressor, class "WJ-3," capable of compressing 628 cubic feet of free air per minute to a pressure of 100 pounds (page 981).

Two mills were erected, one for handling the quartz and a second one for the "grei-

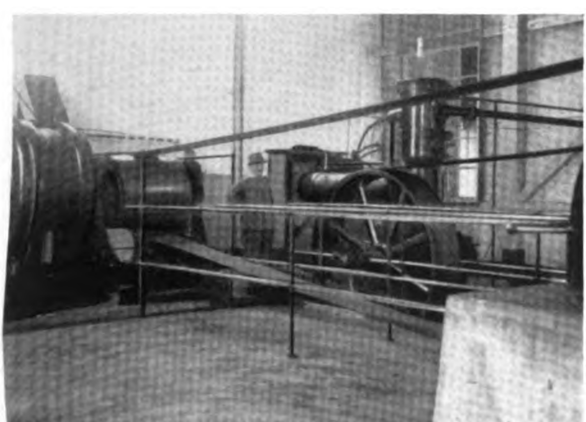
sen," which runs about 2½ per cent of tin metal and one per cent of WO_3, on the average. The combined capacity of the two mills is 200 tons per day, running 24 hours a day and seven days a week. Stoping has just begun. The ore will be mined by a special method, designed by the engineers of the company, breaking it away in horizontal slices of ten feet in thickness and filling with sand, which permits taking out all the ore without any appreciable loss.

Tikoes Mine, Billiton Company, Tandjong, Pandan, Billiton Island, D.E.I.

SULLIVAN WATER TUBE ROTATORS SELECTED

To keep pace with the extension of the workings more Sullivan drills have been ordered. As most of the holes must be drilled horizontally, the need for some other type of drill was felt, which could be mounted on a shell and fastened to a column, using hollow steel and having a washing arrangement for cleaning the drill hole, while at the same time of no greater weight than the hand hammer drills in use, so that one man, with a helper, could easily handle it.

The engineers followed with much interest the descriptions of the new types of drills put on the market during successive years, and welcomed the appearance of the Sullivan drill, known as the "DP-33" rotator, which combined all the features of the type of machine-drill necessary for the conditions in our mine, and more too. Taken from its cradle it is a very efficient hand drill, boring downward holes nearly twice as fast as the former types, though using somewhat more air, due to its greater cylinder size. When mounted in its cradle and fastened to a column it is a complete tunneling machine for boring horizontal and inclined holes. The drill is self-rotating, which in itself is a great improvement over the former machines. Page 979 shows this new drill, in use, both as a hand drill and as a column drill, with its



Sullivan Angle Compound Air Compressor, Billiton Company, Dutch East Indies.

complete equipment with water tank, water hose and air hose and its feed-screw mounting, ready for flat-hole boring.

Any one acquainted with machine-drilling will grasp the great advantage of having the same drill for shaft-sinking and drifting, making necessary only one stock of spare parts, which in a far-away country, such as Billiton is, must be very large. The "DA-21" stoper has already been accepted as a standard machine for the boring of holes vertically upward or nearly so; no doubt the "DP-33" rotator will become our standard for drilling all other holes, because during the period we have been using it, it has given entire satisfaction in every respect.

Billiton, 26 October, 1916.

[Sullivan Diamond Core Drills have also been used for prospecting the Billiton Company's deposits from time to time. —EDITOR.]

ECONOMY IN AIR COMPRESSOR DRIVE

BY R. D. WILLETS*

The accompanying photograph illustrates an unusually economical type of air compressor drive, which is proving its value in the southwest Missouri zinc district. The picture was taken at the plant of the Flannery Zinc Company, of Sarcoxie, Missouri, and illustrates a Sullivan Angle-Compound Class WJ-3 Air Compressor, direct connected to a 4-cycle Diesel oil engine, manufactured by the National Transit Pump and Machine Company, of Oil City, Pennsylvania. The dimensions of the compressor are: low pressure cylinder, 20 inches; high pressure cylinder, 12 inches in diameter by 14-inch stroke. The common speed of the com-

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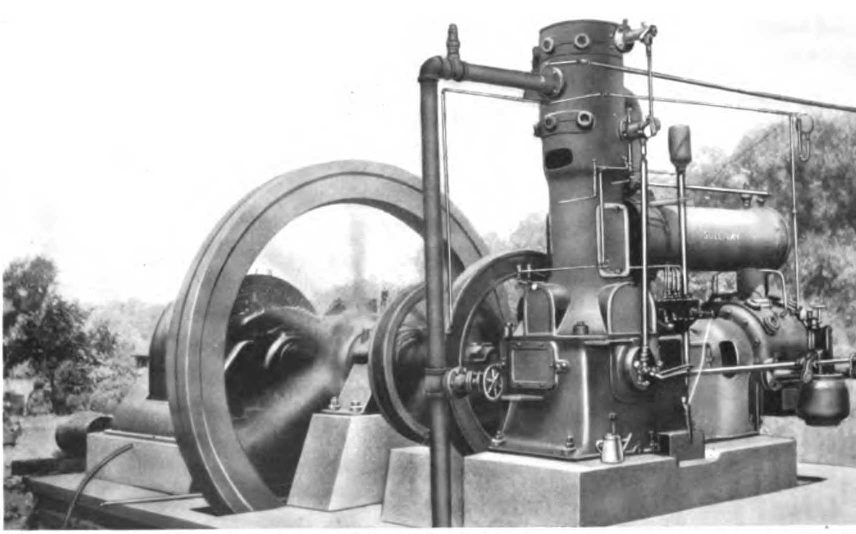

Sullivan "WJ-3" Compressor, direct-driven by an oil engine, operating out of doors at the Flannery Zinc Company's Mine, Sarcoxie, Missouri.

pressor and engine is 175 r.p.m. The engine is a single cylinder, size 21x30, 160 h. p. machine of an improved type. Air is compressed to 100 pounds terminal pressure, and at the above speed the compressor has a displacement of 890 cubic feet per minute.

The Diesel engine is operated on fuel oil, which is (in this case) crude oil from which the lighter products, such as gasoline, benzine, and kerosene, have been removed. At this property, oil having a specific gravity of 24 degrees Baumé is used; but the engines have operated successfully on oil running from 16 to 36 degrees Baumé. At the present time fuel oil costs $1.00 per barrel of 42 gallons at the refinery. The fuel consumption of this type of oil engine is one-half pound of oil per horsepower per hour. The engine, direct connected to the Sullivan Air Compressor, consumes approximately two barrels per eight-hour shift, assuming full load operation throughout the period. On this basis the cost of fuel for operating the compressor is practically one-sixth of a cent per horsepower per hour. This is an exceedingly low rate for fuel and is consistently more economical than electric power drive would be, even under very favorable circumstances.

The photographs show this compressor installed and running on its foundation before the power house was constructed over it. It ran in this manner for several months, giving perfect satisfaction. A few months ago the mill of the company was damaged by fire, but the compressor and its engine were not seriously affected, and are now operating again with their former satisfaction.

The angle compound type of compressor lends itself very profitably to drives of this character, on account of the exact balancing of the reciprocating forces in the horizontal and vertical members of the compressor.

The compressor operates, among other equipment, one Sullivan Drill Sharpener of the all-hammer pattern, ten Sullivan DR-6 mounted water-hammer drills, and a number of Sullivan Class DP-33 Rotator hand-hammer drills.

There are two other National Transit oil engine units in use at this plant. One of these is a 17x27-inch two-cylinder engine, rated at 200 h. p., at 180 r.p.m., which is used to drive the concentrating mill. The other is a 15x24 single cylinder engine, operating at 180 revolutions per minute, and delivering 75 h. p., which is direct connected to a deep well pump. These oil engines have now been in successful operation for over a year and have demonstrated their reliability and exceedingly low power consumption in a very convincing manner.

TURBINAIR IRONCLAD COAL CUTTERS

By Austin Y. Hoy*

Compressed air can fairly claim seniority of use as a motive power for operating coal mining machines. In the United States, the compressed air pick machine enjoyed a widespread popularity in the bituminous field for many years on account of its light weight, flexibility, and simplicity. While these machines are still in considerable use, as indicated by the Government statistics, they have been largely displaced at newer operations by electrically driven machines of the continuous cutting pattern. The advantages of this motor driven machine, of which the Ironclad is an example, are so numerous, and the range of conditions to which these machines are adapted is so wide, that electric drive has rather run away from compressed air in the United States, as the popular method for operating coal cutters.

In Great Britain, on the other hand, air power has always maintained an important position on account of the number

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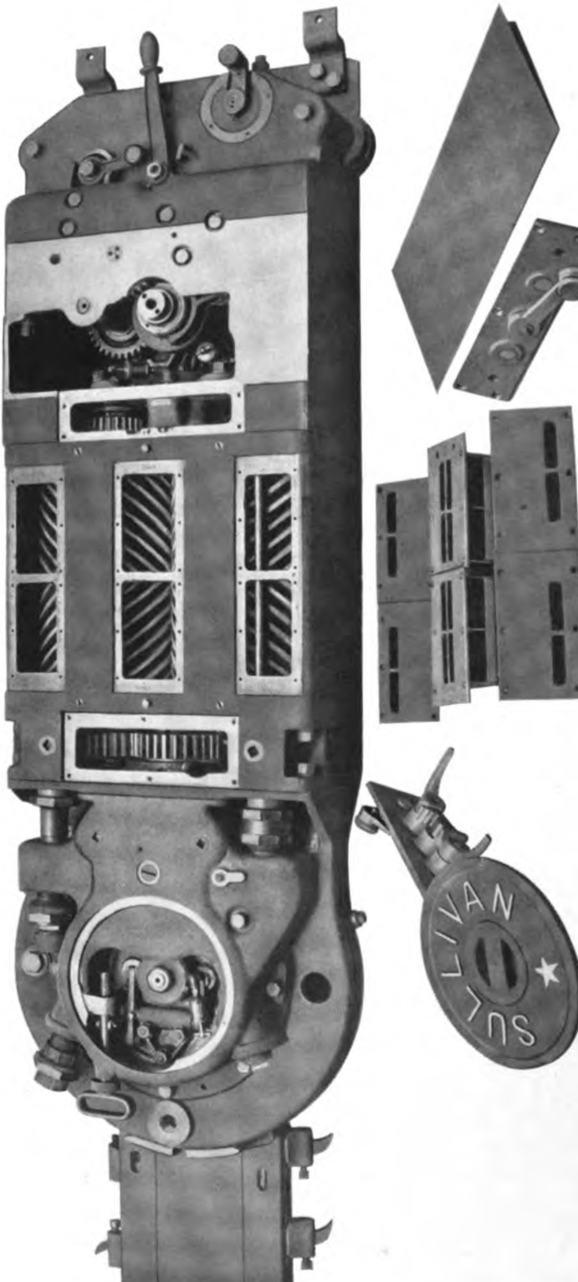


Sullivan Turbinair Longwall Ironclad Coal Cutter with cover plates and exhaust traps removed to show spiro-turbine motors.

of fiery pits or collieries, in which even the carefully protected electric driven machines, permitted by the Coal Mines Act, cannot be employed. There has been a great number of air driven coal cutters of different models brought out in Great Britain, including disk machines, machines of the chain type, of the bar pattern, etc.

For a number of years past, the Sullivan Machinery Company has given attention to the development of a compressed air engine of suitable type to operate its Ironclad Continuous Cutting and Longwall Chain Mining Machines by the power. The problem of designing an engine of sufficient power, and at the same time of sufficient compactness to be practicable for coal mining machine service, economical of power, simple and substantial, to withstand the severe service demanded of it, proved a difficult one to solve. Reciprocating engines with six cylinders and engines with three cylinders were tried, without meeting the requirements to the complete satisfaction of the engineers. Within the past three years, however, the problem has been solved admirably by the adoption of a motor of the spiro-turbine pattern, and Sullivan "Turbinair" Ironclads are in extensive use today in both room-and-pillar and longwall service. In Great Britain, where they have encountered competition from numerous other air machines, this new model has given marked satisfaction.

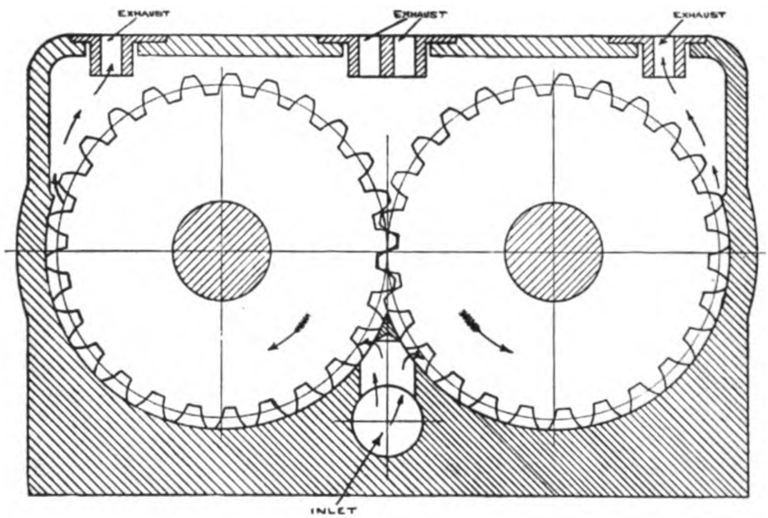
SPIRO-TURBINE MOTOR

This spiro-turbine motor is simplicity itself, consisting of two substantial double helical gears running on ball bearings side by side in the motor casing, with their shafts parallel to the longitudinal axis of the machine. The gears are ground to each other and run without backlash or clearance, in fact, they are paraffine oil tight and form a close fit in the casing in which they run. Their position in the machine is shown by the top view of a class CH-8 Longwall Turbinair Ironclad with the cover plates removed (page 984). Air is admitted between the teeth of the rotors through a small port, as indicated in the sketch on page 986. The air is cut off by the turning of the gears, and is expanded until just before the end of the teeth run out of engagement, when these teeth run over a shoulder in the casing, discharging the air into the atmosphere. The pockets between the teeth where air is admitted are of constantly increasing size, and the air is, therefore, expanded several times before being exhausted.

The action of this motor may be explained by reference to the diagram on page 987. Suppose two small pistons, A–A′, are inserted in a "V" shaped groove and the top of the groove closed by a casing ("C" in cross section). If air were to be admitted to the apex of the "V" at the point "B" and then cut off, the pistons would be driven to the extremities of the "V," a–a′. Now, if instead of two pistons the line of contact of another gear is substituted, the action of the turbinair gears is clear.

The rotors always run in one direction, and the power is taken from one or the other rotor, according to the direction of operation desired. A simple and ingenious gear shifting device is provided on top of the machine. This is arranged so that both rotors cannot be simultaneously engaged. A similar device is provided for reversing

A Turbinair Rotor



Diagrammatic cross section through the centre of a Turbinair motor.

the cutter chain sprockets. Exhaust traps are provided, so that dirt falling on top of the machine is blown off and cannot enter the motor.

These spiro-turbine motors have no blades or buckets, and consist essentially of only two moving parts of the most substantial possible construction. Machines in constant use over long periods have required no renewal, while inspection of the first machines put into use over three years ago, reveals no appreciable wear.

It is interesting to note that this exceedingly simple compressed air engine requires no valves, no stuffing boxes, piston rings, or other small or delicate parts, which might require renewal or frequent adjustment.

It should be noted that the teeth of the rotors are carefully hardened to meet the severe requirements of the service to which they are put, and in addition, with the lubricant employed, rapidly acquire a glass hard finish, which is permanent.

Comparative silence and entire freedom from vibration are among the valuable characteristics of these motors. Water has no injurious effect on Sullivan Turbinair motors, a point which should be noted, due to the serious breakages resulting in rapid-running reciprocating engines when water is inadvertently admitted. In coal mining service, the presence of water is occasionally unavoidable.

Air is admitted to the rotors by a throttle valve of the poppet type, arranged so as to close automatically in case its operating mechanism should become deranged. Turbinair coal cutters may be operated on any air pressure, from 20 to 75 pounds. The power developed is naturally much greater at the higher pressures. The air hose may be attached on either side of the machine for convenience.

AIR CONSUMPTION

The air consumption per brake horsepower is somewhat less than that of the best reciprocating engine-driven coal cutters when the cutter is in first class condition. The consumption of air does not appear to increase with long continued use, while it is a matter of common knowledge that the air consumption of recipro-

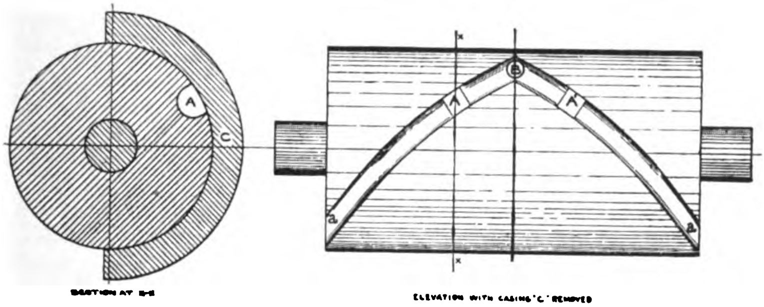


Diagram to illustrate principle of Turbinair motors.

cating engines in coal cutters is largely increased with even slight wear, or lack of careful adjustment.

Reports from Turbinair Longwall Ironclads, as used in Great Britain, indicate their low air consumption per square yard of coal undercut. A British colliery conducted careful tests on the air consumption of their Turbinair machine, with the result that it appeared that this machine required one-third less air per square yard undercut, than another type of air coal cutter, in the same mine. This result appeared startling to the management and the test was repeated, but with the same results.

A simple and effective lubricating device introduces oil with the air in Turbinair motors, and but little oil is required for successful work.

The motor section of Turbinair Ironclads, whether of the room-and-pillar or longwall pattern, is interchangeable with the motor section of direct current or alternating current electric Ironclads, and the change from air to electricity or vice versa, may be made in the field if desired. Turbinair motors develop 45 horsepower at a pressure of 50 pounds per square inch, the power developed decreasing as the pressure falls off, and increasing as the pressure employed increases. At 50 pounds pressure the speed of the rotors is 1200 revolutions per minute. The power thus developed is transmitted to the cutter chain of the Ironclad machine, by a simple gearing attachment. A power truck, also operated by air power from the machine, is provided for moving room-and-pillar machines, and its operation is similar in principal particulars to that of the electric driven power car.

Sullivan Turbinair machines are in extensive use on longwall work in Great Britain and to a less extent in this country in room-and-pillar mines, but with the utmost satisfaction to their owners wherever they are employed.

Sullivan Turbinair Ironclad Coal Cutter Swinging in to the face of the coal in a British colliery.

DRILL BITS AND DRILL STEEL

By George H. Gilman*

[Editorial Note: The article printed below is the first section of a paper published in *Engineering and Mining Journal* of May 12th, 1917, under the title "Drill Bits and Drill Steel for Metal Mining." The second portion of the article, dealing with the selection of proper steel, its tempering and treatment, also a further discussion of the reaming qualities of different bits, with especial reference to the double arc bit described in this article, will appear in the next issue of Mine and Quarry. Readers interested in following this matter up immediately are referred to the *Engineering and Mining Journal* of July 28th; or a copy of the remainder of this paper may be obtained from the editors of Mine and Quarry. The editors of *Engineering and Mining Journal* say, in reference to Mr. Gilman's paper, "This in our judgment will long be a classic in its field. The experience (of drill users and drill steel manufacturers, as well as that of drill manufacturers) is crystallized in this article, which has shown the true spirit of co-operative research. We look forward to most startling strides in the rate of drilling and reduction of drilling cost in the next few years, which can be both hastened and increased by fullest co-operation between the miners, the steel maker and the drill manufacturer."

While this paper first appeared in a mining journal, it is just as valuable for quarrymen, contractors and any one else using rock drills, hammer drills and drill steel, as for metal miners.]

It is with the object of assisting in the effort to place mining with rock drills on a higher plane that this paper has been prepared. The facts presented have been gained by observation of standard methods in different sections of the country, supplemented by a knowledge of the requirements for varying conditions under which rock is excavated, secured only through experimental and research work.

The great wave of scientific mining that is sweeping the country at the present time has resulted in a great deal of thought and study being given to the rock-drilling end of the work, which is, beyond doubt, the "business" end of the whole proposition. The problem of determining the type and size of rock drill, its steel, mounting, hose and accessories best adapted to the existing conditions of ground is receiving serious consideration, supplemented by a study of the best methods for breaking ground, as regards the size and depth of drill hole, the number of holes, their relative position and angle, and the size, grade and amount of explosive required.

Furthermore, an effort is being made to minimize the personal equation which has always been a serious factor in the drilling operation. The importance of this is emphasized by the scarcity of skilled labor and the workmen's compensation laws which prevail in all territories, together with the fact that the average mine manager is a humanitarian by virtue of his position and environment. This means that, so far as possible, the work of breaking ground is being made as simple and as easy for the workmen as the present state of the art will permit; summarized under the one word, "efficiency."

In view of obtaining desired results in this connection, it is recommended that the mine management seek the coperation of the rock-drill manufacturer in determining the type and size of rock drill that meets, to the best advantage, the prevailing conditions of the work to be executed. A knowledge of the requirements of different grounds, considering the methods under which the work is to be executed, is gained only by experience and observation, coupled with an intimate knowledge of rock-drilling machinery and modern rock-drill practice.

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In general it may be said that the best type of rock drill for any condition is the one that will cut the greatest number of feet of drill hole in the least possible time with minimum exertion on the part of the operator and at minimum cost.

PRIMARY MACHINE FACTORS AFFECTING DRILLING EFFICIENCY

The primary machine factors (eliminating hose, steel and mounting) that determine the efficiency of rock drilling are: Force and frequency of blow, speed and strength of rotation and ejection of cuttings or sludge from drill hole. Secondary factors are: Feeding and retracting the machine to and from its work, extracting stuck drill steel, changing drill steel, adequate lubrication for the machine and drill shank, means of allaying dust, adjustability of machine to conform to variation in the alignment of the drill hole and convenience in handling.

The foregoing being the determining factors, it is doubtful if any are in better position to establish the requirements of a fixed set of conditions than the rock-drill expert of the manufacturer, who, by virtue of his work, has a training thrust upon him that enables him to make recommendations based on experience and observation.

It is a deplorable but nevertheless a well-known fact that no one type or size of the so-called standard rock drill will meet all conditions of ground and air pressure to the best advantage. In developing a standard machine all that it is possible for the rock-drill designer to do is to adapt it to meet to the best advantage the average conditions as he may have found them. It is then necessary to incorporate special features in the drill in order to have it meet more closely the conditions of the work that vary from the average, and on those special features the experts and salesmen of the manufacturer are informed, both as regards their make-up and function.

Too much emphasis cannot be placed upon the desirability of introducing scientific methods underground for breaking rock. It is folly to drill 20 holes in a heading if the same amount of ground may be pulled with 16. Furthermore, it is folly to assume that because a round of holes can be drilled in three hours, the drilling period is over. It is much better to so arrange the work that the drilling crew can put in two rounds in a shift's period, or the equivalent in footage by deepening the one round. In other words, the work should be planned so that the machine may be kept in operation for as great a portion of the shift's period as possible. When one considers the fact that under average present-day practice rarely more than 30% of the shift is consumed by the drill in actually hammering upon the rock, it is unnecessary to elaborate upon the importance of minimizing the personal equation as applied to the operating of the drill.

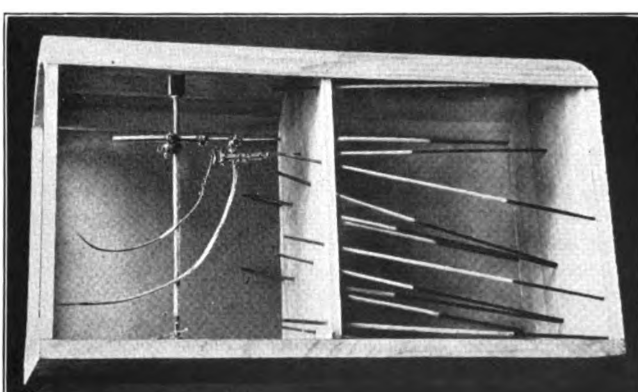


Fig. 1. Model to show depth and angles of drill holes.

Production is dependent on drill footage, but it is up to the mine management to see to it that the drill holes are properly positioned in order that the maximum amount of rock may be broken for the minimum amount of drilling. It is well in this connection to bear in mind that no more time is consumed in drilling a hole that is properly positioned and spotted than one that is drilled solely for the purpose of adding to the shift's footage regardless of its effect upon the ground. Disregarding the conditions under which rock drills operate, it is folly to use a larger or heavier mounting than is necessary to support the drill or drills without undue vibration, and it should be borne in mind that much lighter columns or bars are required for drills equipped with a pneumatic feed than for machines for the feed-screw type, owing to the fact that the pneumatic feed serves to absorb vibration by virtue of the air cushion provided in the feed cylinder.

In determining the size and weight of mounting required for drift or stope work in which the column type of support is employed the following points should be considered: Width or height of working place measured from abutment to abutment; number of machines to be mounted on column; type and size of machine to be used; if a column arm is to be employed, the length of the arm; if a horizontal bar is used with or without arm, the desirability of employing a center leg brace to insure rigidity; hardness of the rock to be drilled; and air pressure.

SIZE, DEPTH AND ANGLE OF HOLES

It is good practice to experiment in different grounds to determine the best size of hole, depth, angle and, above all, the number required to break the maximum tonnage, with the least amount of drilling and with the minimum amount of powder. It should be the duty of superintendents, mine foremen and shift bosses to determine what may be accomplished in this direction and then to see to it that the miner is instructed accordingly. It is inadvisable to leave these points for the miner to decide. Remember that he is not as a rule in a position to analyze his troubles as well as his superior, nor is he able to study his work from as wide an angle. After these points are determined by experiment, they may be graphically impressed upon the men by using models which may readily be made from boards placed in proper position to represent the working face of the ground and with steel rods or wires placed in position to represent the position and angle of the drill holes required to properly break the ground. Such a model is illustrated by Fig. 1.

One of the most important points to determine in the breaking of ground is the smallest size of drill hole, at its bottom diameter, that will break successfully the burden imposed upon it. This will to a great extent govern both the size of drill and its drill steel. The character of the rock largely governs the strength of powder required and the type of rock-drill bit that may be employed to the best advantage, and both the character of the rock, the type of rock-drill bit and the length of the feeding means govern the variation in the gage of the bit or "drop" for each following length of drill steel. It is folly to use a drill steel of heavier section than is required to withstand without undue breakage the blow of the hammer drill required to cut the ground to the best advantage, for the larger the steel used, the greater the absorption of energy in transmission to the rock, and furthermore, the size of the drill steel may govern the bottoming diameter of the drill hole. Where a variation in gage of $\frac{1}{32}$ in. between following steels is sufficient, the difference of $\frac{1}{8}$ in. or even $\frac{1}{4}$ in., not uncommon in practice, should be discouraged, for it must be remembered that the speed of drilling in rock is in direct proportion to the amount of rock removed from the drill hole and varies nearly inversely as the area of the drill hole. It is also ap-

parent that the effectiveness of the drill hole in pulling the ground is determined solely by its bottom diameter, and when this is established, the less the variation in size between the bottom and its mouth the greater will be the speed of drilling and the lower the cost per unit of rock broken.

PROPER TYPE OF DRILL BITS TO USE

A great deal has been written in regard to the proper type of drill bit to employ for cutting rock, and it is a subject that is entitled to all the consideration it has received; but unfortunately this phase of mining has been woefully neglected, and today the old type of cross-bit is accepted by the majority of mining men as the standard for all conditions.

The essential qualifications of a rock-drill bit, regardless of the conditions under which it is operated, are that it must be made in such a manner that maximum cutting speed is maintained for as great a distance as possible before wear of the cutting edge reduces the speed of penetration to a point where a change of steel is made necessary; that the size or diameter of the drill hole corresponding to the gage of the bit is maintained with the least possible reduction as the depth of the hole increases; that the shape of the bit is such that it may be correctly formed and tempered with the least amount of exertion on the part of the forge smith.

The type of rock-cutting bit for hammer-drill service that will meet to the best advantage any fixed set of conditions is determined only by a careful investigation in which force and frequency of the blow transmitted to the bit, speed and strength of rotation imparted to the drill steel, the character of the rock as regards hardness, abrasion and cohesion, and the method to be employed for the ejection of sludge or rock cuttings are items on which all conclusions should be based. The following features of design should each receive individual consideration: Shape of the cutting edge; total length of cutting edge; angle of cutting edge; length and area of the reaming edges or surfaces; size and shape of clearance grooves for the ejection of rock cuttings; length and angle of the wings and the manner in which they are blended into the body of the steel; uniformity of metal adjacent to the cutting edges; adaptability of the bit to the available sharpening facilities.

The length of the cutting edge (by which is meant the combined length of the cutting edges) and the manner in which it is applied to the work form a determining factor in the drilling operation as regards speed and also as applied to the life of the drill steel and its actuating engine. We might naturally assume that within reasonable limits the longer the cutting edge the greater will be the amount of rock particles disengaged from the mass for every blow delivered; and that a long cutting edge would naturally be conducive to rapid drilling. But this applies only as long as the cutting edge remains sharp, which it naturally does for a longer period in soft, non-abrasive material than in hard, gritty or abrasive rock; but we must consider the effect of a dulled or blunt cutting edge, as the combined area of the blunt edge of all the cutting surfaces determines the cushioning resistance, which naturally governs the penetration per blow, and a decrease in penetration results in a lessening of the cushioning effect, which in turn has a tendency to cause the drill steel to rebound from the rock; this, when carried to excess, causes breakage of the drill steel, the hammer of the drill and, in the absence of an effective means to properly cushion the drill piston on its rearward stroke, breakage of other parts of the drill, including the back head, side rods, springs, etc. This action may be emphasized by operating a hammer drill under exaggerated conditions, with the cutting end of the drill bit made blunt, upon an impenetrable hardened steel block.

The manner in which the cutting edge is applied to the work in the bottom of the

drill hole is equally an important factor in determining speed as the length of the cutting edge, and it also governs to a great extent the life of the cutting edge. When drilling a round hole in rock, the work that the bit has to do is to separate the rock particles from the mass, not only as applied to the bottom of the drill hole, but also from the side walls. This imposes a heavy duty upon the extremities of the cutting and reaming edges of the bit, and the amount of work that the cutting edge must do increases, not in proportion to the diameter of the hole, but in proportion to the square of its diameter. As an illustration, when drilling a 1-in. diameter hole, we remove 0.7854 cu. in. of rock per lineal inch of advance, but when drilling a hole 2 in. in diameter, we remove four times this amount, or 3.1416 cu. in. of rock per lineal inch of advance, and in the case of a 3-in. diameter hole we remove nine times as much rock as we do in a hole 1 inch in diameter. This accounts for the unequal wear that takes place along the cutting edge of a radial cutting bit, which, if uniformly tempered, will result in a gradually increasing flattened edge radiating from the center. Furthermore, the extreme outer ends of the cutting edge have imposed upon them the additional duty of dislodging the rock particles from the side wall of the drill hole, which, if the bit is not equipped with an ample reaming edge or surface, results in the outer edge of the bit being rounded, thus reducing the diameter of the hole being drilled and decreasing the speed of penetration, with the natural effect of increasing the rebound of the steel from the work. It has been determined by experiment that this condition may be improved in two ways—first, by so shaping the cutting edge that the work is approximately evenly distributed throughout its length and, second, by equipping the extremities of the cutting edge with suitable reaming edges or surfaces which determine the wearing qualities of the gage.

ANGLE OF THE CUTTING EDGE

The angle of the cutting edge should be great enough to withstand the shock to which it is subjected in service without danger of breakage, but it should not provide for more than a reasonable factor of safety, as the greater the angle the less will be the cushioning effect due to penetration and the greater will be the rebound from the work, which, if carried to the extreme, will result in disaster to the drill and its steel. For soft ground a more acute angle than 90 deg. generally works to better advantage than a greater angle, but for the harder ground the requirements are reversed.

The diameter of the reaming edge, or surface, must be greater than the diameter of any other part of the bit in order to permit of free action in the hole.

In Fig. 2 is illustrated the manner in which a bit may be developed by projection to determine the appearance of the different views, and this method of procedure is recommended as the preliminary step of development. The lines *A-A* represent the cutting edge, and the lines *B-A-C* the reaming edges. In all cases the diameter of the extremities of the cutting edges *A-A* should equal the diameter of the reaming edges, as shown in the end view, which necessitates the reaming edges being formed in an arc of a circle the diameter of which is equal to the extremities of the cutting edges. The necessary clearance is provided for the bit by tapering the wings or body portion back toward the drill-steel bar, and if the wings are flattened at their outer, or opposing edges to secure clearance for the reaming edges, care must be taken during the flattening operation to see that the shape of the reaming edges is not distorted.

A good way to determine if the finished bit possesses the required shape of reaming edges and clearance is to employ a ring gage of the same bore as the gage diameter of the bit. This, when passed over the bit and held in axial alignment

thereto, should engage by line contact the reaming edges throughout their length, from which the bit is tapered rearwardly to provide clearance.

In the preceding paragraphs reference has been made to the reaming edge. For certain kinds of rocks a reaming edge is desirable only to insure the required clearance for the bit, especially if the formation is tough, close-grained and not excessively abrasive; but in abrasive rock that is easily fractured, a reaming surface curved concentric with the axis of the bit and varying in area dependent upon the conditions is often employed to good advantage.

SHAPE OF THE CUTTING EDGE

It is not a difficult matter to secure proper sizing and shaping of rock-drill bits when a machine sharpener is employed, but it is desirable that the gaging of the bit be performed in independent sizing grooves, supplementary to the main forming grooves in the swaging dies of the sharpener. The reason for this is that the curved surface of the reaming edge for any fixed angle of cutting edge and width of wing varies in its degree of curvature with the diameter of the bit, necessitating a tapered sizing groove in the dies of the drill sharpener, varying in its shape to correspond with the variation in the curve, as illustrated by Fig. 2. When this sizing groove is available, the correct shape of reaming edge or surface for the various gages required in a set of drill steel may be secured by employing a movable stop piece in the dies of the drill sharpener to properly position the steel being worked upon. It is good practice first to form the bit in the shape of a cone which provides for the required taper of the wings or body portion, at a slightly larger reaming-edge diameter than that of the finished bit, after which the required gage diameter is secured by swaging down the extremities of the wings or body in the sizing groove.

The taper of the wings or body of the bit is governed by the size of the bit with relation to the drill steel, the character of the ground and the force of blow. In hammer-drill practice it is not so essential that a long tapered wing be employed as was the case with the reciprocating type of rock drill, but preferably a wing taper of 14 deg., modified adjacent to the cutting end to conform with the curvature of the reaming edges, will meet the requirements of the average conditions of ground satisfactorily.

The sizes of clearance grooves are largely dependent on the type of bit used and the character of the ground. They should be large enough to permit free egress of the cuttings.

Dead corners in the cutting edge of the bit are undesirable and should be avoided whenever possible. The practice of making bits with concave or convex cutting edges is largely a matter of opinion, based on the conditions encountered. A convex, or raised center bit, is oftentimes desirable in starting drill holes, especially with stoping drills equipped with a pneumatic feed, while concave bits will assist materially in maintaining the alignment of the drill hole. However, tests that have been conducted show no advantage as regards stamina or drilling speed when compared with flat-ended bits identical in all other respects.

LENGTH AND AREA OF REAMING EDGES

It has been determined by experiment that the chisel, or single cutting-edge, type of bit is a very fast driller, but when made rectangular in section, the reaming edges are very susceptible to wear. This applies to any bit employing an angular reaming edge with respect to the circumference of the drill hole. The reason for the general adoption of a cross- or an X-bit in preference to a chisel is because they are less susceptible to rifling the drill hole, owing to the greater reaming surface provided by the extremities of the four wings, and consequently they may be used for drilling through a greater dis-

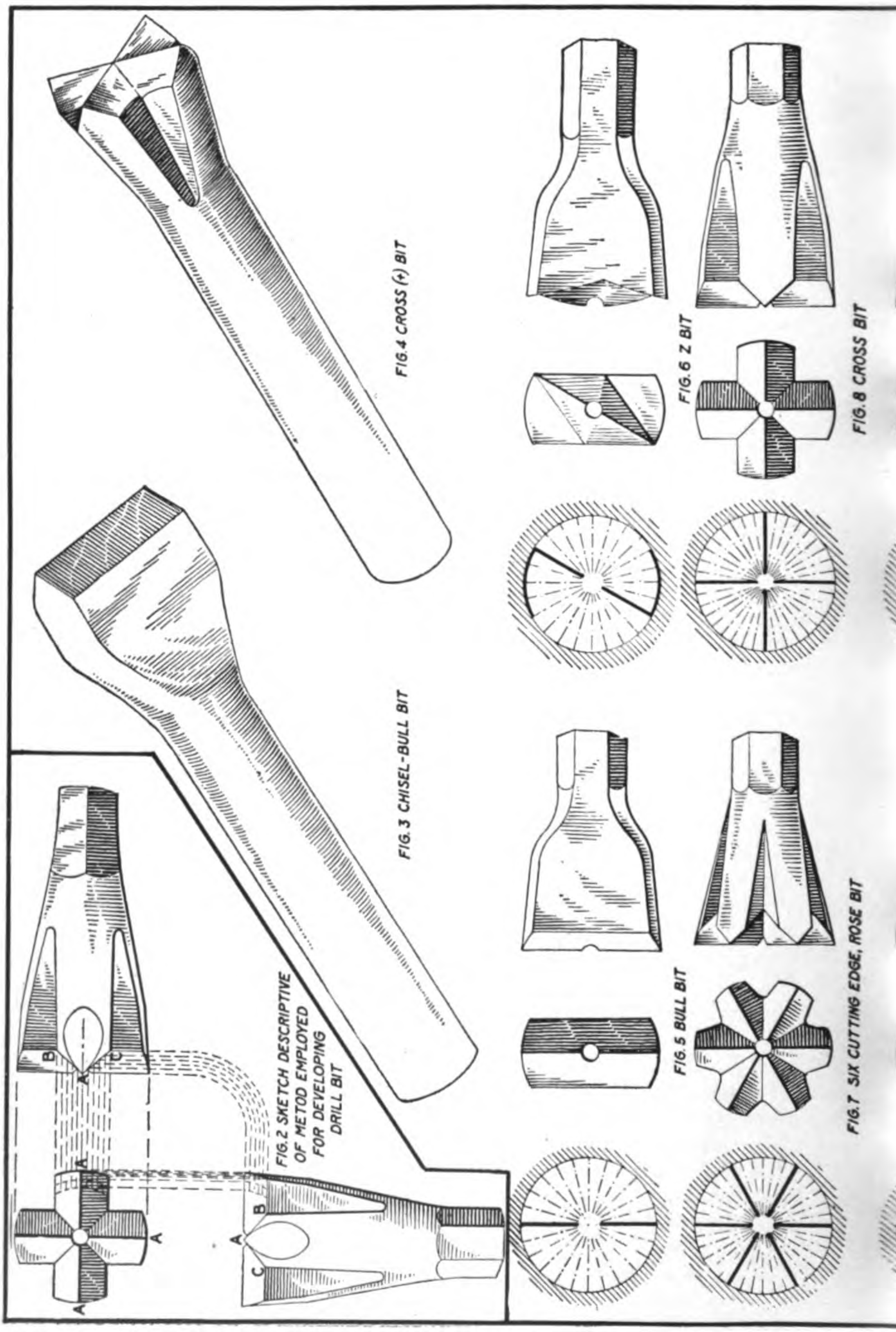


FIG.2 SKETCH DESCRIPTIVE OF METOD EMPLOYED FOR DEVELOPING DRILL BIT

FIG.3 CHISEL-BULL BIT

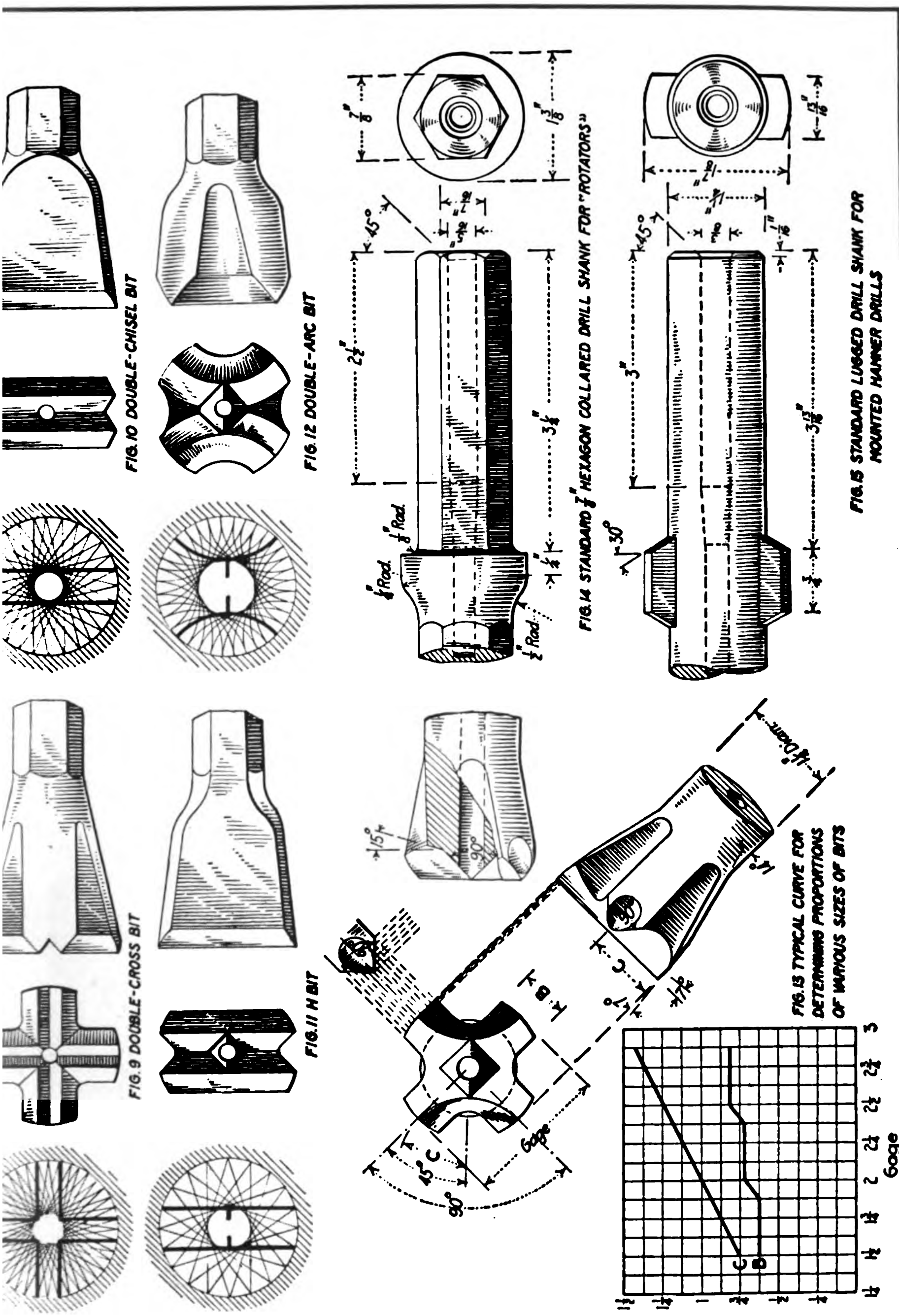
FIG.4 CROSS (+) BIT

FIG.5 BULL BIT

FIG.6 Z BIT

FIG.7 SIX CUTTING EDGE, ROSE BIT

FIG.8 CROSS BIT



Types of bits and shanks, with typical curve diagram for determining proportions of various size bits.

tance before wear of the reaming edge makes necessary the use of the following length of steel with a reduction in the size of the gage. This is illustrated by Figs. 3 and 4.

The bull bit, Fig. 5, corresponding in many respects to the so-called Joplin bull bit, which for a great many years has been considered the standard type of drill bit for the Joplin-Missouri zinc district, on account of its blunt-angled single cutting edge, possesses a greater crushing than wedging action, which is advantageous in a hard, brittle ground, as it results in a shattering action to the rock, which, if it is of such a nature that this action can be taken advantage of, will secure rapid penetration. Instead of the reaming surface being angular in section, it is made concentric with the axis, which has the effect of preserving the gage by virtue of the bearing surface. While a bit of this type was and is desirable for Joplin conditions to enable the ground to be drilled economically owing to the abrasive qualities of the cherty flint rock that prevails throughout the district, there is no good reason why the predominating feature of the Joplin bit should not be taken advantage of in other formations, thus causing the drill bit to cut to a greater depth, or by reducing the variation in gage of the following steel without affecting the linear depth of hole that is drilled before a change in the size of bit is made necessary by wear. This bit is not, however, recommended for drilling in ground the rock particles of which cannot be readily shattered or disintegrated. Because of the chunky shape of the bit, it lends itself readily to uniform tempering at both the cutting and reaming edges.

A composite bit, made by incorporating the advantages of the single cutting-edge chisel bit as shown by Fig. 3 in combination with the predominating feature of the bull bit, Fig. 5, may have the appearance of the Z-bit shown by Fig. 6, which possesses in addition advantages that are not inherent in the other types to which we have referred.

The arc-shaped cutting edges, which are made as terminals of the diagonal, provide for ample reaming surface, besides determining the gage of the bit; and in action they serve to cut a channel around the periphery of the drill hole, which reduces the work of the diagonal by rendering the rock within the circular channel easily broken. Theoretically, this type of bit combines many of the advantages of the other bits described, but owing to its shape difficulty is liable to be experienced in tempering the cutting edge uniformly, and as a result the arc-shaped terminals of the cutting edge are very likely to be made harder than the diagonal, which, on account of the burden imposed upon them in practice, results in chipping.

The rose bit as shown by Fig. 7 and the cross-bit as shown by Fig. 8 illustrate common and well-known types of radial-cutting-edge bits, and the foregoing statements apply equally well to either type, although the cross-bit has a shorter cutting edge than the former, and for this reason lends itself to better advantage as applied to hard rock than a radial bit possessing a greater length of cutting edge. If incorrectly formed as regards its reaming edge or surface, it has a tendency to drill a rifled hole, which is not possible with a bit of the rose type having a greater number of cutting edges with corresponding supporting wings.

THE DOUBLE CROSS-BIT

In Fig. 9 is illustrated the double cross-bit, which possesses a desirable advantage over those previously mentioned. As shown in the figure the cutting edges of this bit are not positioned radially with respect to the axis of the bit, but are offset in such a manner that, as the bit revolves in the drill hole, the depressions made by the cutting edges intersect and cross each other in such a way that the work is more evenly distributed over the entire length

of the cutting edge and the rock is thus broken diagonally as well as radially. When sharp, the long cutting edge of this bit, in conjunction with its intersection of the cutting depressions in the work, provides for very high drilling speed in a variety of rocks, but in hard ground the cutting edge, when dulled, is very likely to result disastrously to the steel and drill parts. A bit of this type possesses reaming qualities superior to that of the cross, on account of the better distribution of the work over the cutting edge, which relieves the extremities from a greater part of the load that they would otherwise carry in disengaging the rock particles from the wall of the drill hole. It will drill a round hole, equal in this respect to the rose bit, but it is not an easy bit to make, owing to the difficulty experienced in causing the metal to flow when being forged to the extremes of the cutting edge.

Difficulty is likely to be experienced in securing a uniform temper for the cutting edges of the cross and the double-cross bits, owing to the size of the clearance grooves adjacent to the extremities of the cutting edge, which provide for a greater surface of conductivity for the quenching fluid. If care is not exercised in the tempering operation, the heat from the center of the bit is likely to run down and draw the temper of the cutting edges at the center to such a degree that the bit will become battered at this point, before the extremities of the cutting edge are worn a corresponding amount. This difficulty is not so pronounced in drill bits of more uniform or massive section.

The double chisel bit, as shown by Fig. 10, has practically the same advantages, as regards the intersection of the depressions in the bottom of the drill hole, as the double-cross, and although its cutting edge is shorter by nearly 50%, it does not possess sufficient reaming surface and consequently wears rapidly with a reduction in the gage diameter. When drilling in rock formations that do not crush readily the cone center that projects in the bottom of the drill hole will retard the penetration, and if the axial hole of the drill steel terminates in the depression midway of the cutting edges, it is liable to become plugged with rock particles or sludge. This is overcome in the H-bit, Fig. 11, by the addition of the intersecting transverse cutting edge, but although a fast cutting bit for a great variety of conditions when sharp, this bit is subject to the same criticism as its forerunner, and besides it has two dead corners at the junction of the cutting edges, which are not conducive to rapid penetration.

NEW TYPE OF DOUBLE-ARC BIT

The double-arc bit, shown by Fig. 12, is the result of an attempt to develop a bit that would meet the average conditions of ground encountered, by retaining as many as possible of the advantageous features possessed by other standard bits, one that would readily lend itself to machine sharpening, and, in addition, one the cutting edge of which might be tempered easily and uniformly. To insure this result, it was necessary to resort to a great deal of experimenting under a variety of conditions of ground, force and frequency of blow and speed and strength of rotation. In the comparative experiments conducted, the various drill bits were all hammered and subsequently machined to correct shape of corresponding size, micrometers being used in making measurements. All bits were tempered uniformly, a pyrometer being used for the heating bath, and all drill steels were made from the same material. All comparative tests were made with steels of corresponding weight, length and gage of bits, operated upon under identical conditions. The drill holes were carefully calipered every 6 in. of advance, and the condition of the bits was recorded. As a result of the experiment it was found that the double-arc bit possesses greater stamina as ap-

plied to its cutting and reaming edges, permitting it to be used through a greater distance of drill hole before a change of steel is made necessary; that it possesses cutting capacity, when sharpened, equal to any of the others; that its cutting speed is not reduced as the depth of the drill hole advances to so great an extent as with bits of other types; that wear of the cutting edge is approximately uniform throughout its length, that only a slight reduction in gage results as the depth of the hole increases; and that it may be tempered uniformly throughout the length of the cutting edge. As shown by the diagrammatic drawing, Fig. 12, which illustrates the action of the bit in the bottom of the drill hole, the depressions made by the arc-shaped cutting edges intersect each other as the bit is rotated, while the connecting cutting edge prevents a cone from forming in the bottom of the drill hole, exactly as it does in the case of the H-bit. A perfectly round hole is drilled, and the reaming edges are maintained by virtue of the reaming surface and the manner in which the work is distributed throughout the length of the cutting edge. Owing to the chunky nature of the bit immediately behind the cutting edges, in tempering, the heat retained in the mass is distributed evenly upon the cutting edge, thus securing uniformity where it is required.

After a particular type of drill bit is decided upon and its general shape is determined by experimenting under actual working conditions, it is good practice to proportion the various sizes of bits required for completing a drill hole by making a reference drawing and establishing curves between the minimum and maximum sizes, in which all dimensions for any size or gage of bit may be seen at a glance. A typical curve sheet with sketch applicable to the double-arc type of bit is shown by Fig. 13. For the requirements of this country these curve drawings are preferably made on cross-section paper $\frac{1}{8}$ x $\frac{1}{8}$ in., and if necessary the curves may be made to double scale as has been done in Fig. 13. For example: To determine the dimensions of a bit of $1\frac{3}{4}$-in. gage, refer to the ordinate indicated by the $1\frac{3}{4}$-in. gage dimension at the bottom of the plate and follow this up through to the point of intersection of the various curves corresponding to reference letters to those on the sketch. The vertical height at the point of intersection will give the dimension required.

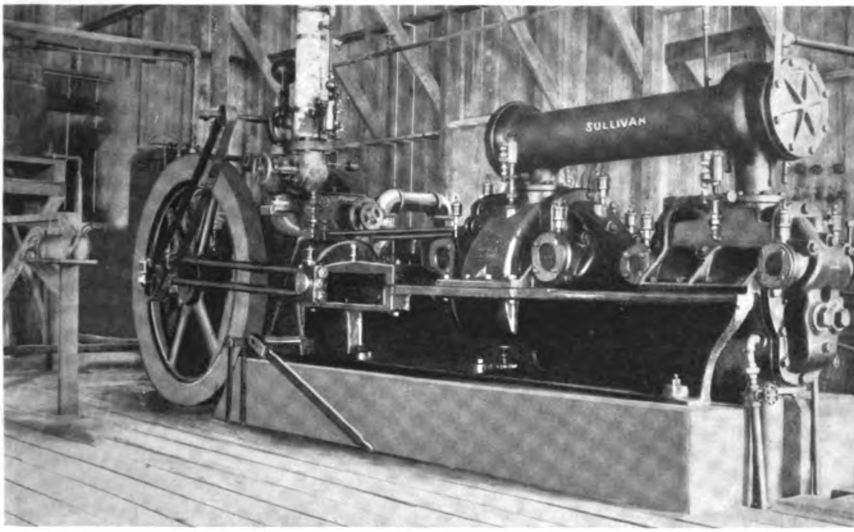
(To be continued)

NEW PUBLICATIONS

SULLIVAN DIAMOND CORE DRILLS, Catalogue No. 69, 68 pages and cover. Complete descriptive catalogue of the Sullivan Diamond Core Drills, liberally illustrated with halftones of the machines and of diamond drilling operations, with a chapter on instructions for using diamond drills, setting diamond bits, etc. Contains lists of drilling equipment.

SULLIVAN SUBMARINE ROCK DRILLS, Bulletin 70-E, 16 pages. Describes not only the Sullivan types of heavy duty reciprocating piston drills for removing rock under water, but also gives interesting and valuable reference data on drill carriages or towers and other equipment for this special class of rock excavation.

SULLIVAN ANGLE COMPOUND AIR COMPRESSORS, Bulletin No. 75-C, 32 pages. Describes the Sullivan class "WJ-3" belt driven, class "WN-3", direct connected, single angle compound, and the Sullivan "WN-4" and "WJ-4" direct connected and belt driven twin angle compound compressors. Contains description of the Sullivan plate valves, which are now standard on these compressors, and of the Sullivan three-pass, counter-current intercoolers.



Sullivan "WB-2" Air Compressor of the Texas Trap Rock Company.

QUARRYING BASALT IN TEXAS

CONTRIBUTED

The Texas Trap Rock Company, with offices in San Antonio, has for the past three years been quarrying an interesting deposit of basalt rock, which occurs in the form of a dome-shaped hillside on the west side of the Frio River, just south of the main line of the Southern Pacific Railway at Knippa, Uvalde County, Texas. The rock, which closely resembles the trap of Maryland and New Jersey, is very tough with a high crushing strength, breaks in cubical form and makes an excellent material for the wearing surface of country highways or city pavements. The left cut on page 1000 shows the interesting character of this deposit, with its distinctive columnar structure. The working face is from 50 to 80 feet high and the basaltic columns stand on end with a slight inclination from the vertical.

The Texas Trap Rock Company has installed a compact but efficient plant for reducing this stone to marketable proportions. The rock is removed from the hillside by drilling toe-holes with two Sullivan 3⅝-inch "Hy-speed" rock drills mounted on tripods, as shown by the small photograph on page 1000. These holes are spaced 6 to 8 feet apart and are sprung and then loaded with 60 per cent dynamite. The rock units are very hard and yet the joint seams are not compact, making the drilling proposition a difficult one. The two drills enable the required production of 500 tons per day to be readily maintained. The working face is about 600 feet in length and a number of holes are shot at one time. The jointed structure of the rock causes the shooting to be very effective, and between eight and ten thousand tons have been thrown over by a single round of holes.

When necessary, the rock is reduced to handling size by block-holing with hammer drills, or sometimes, in the case of large fragments, with the tripod machines. The drills are supplied with air at 100 pounds pressure by a Sullivan "WB-2" straight line, two stage, steam driven air compressor with a capacity of 550 cubic feet of free air per minute. The com-

The Quarry Face, Showing Result of a large blast

Sullivan Hyspeed Drill at the Knippa, Tex., Trap Rock Quarry

pressor, with the Corliss engine necessary to drive the mill, is located 900 feet away from the quarry, in a power-house on the other side of the river. The cars of stone are hauled up a six per cent incline to the crusher dump, where crushers and rolls of various sizes are installed to reduce the rock to the several market dimensions required. Crude-oil burners on two boilers of 125 horse-power each furnish steam for the plant. Water supply is secured from wells 200 feet in depth.

Mr. A. H. Muir is general manager of the Texas Trap Rock Company and Mr. Douglas Muir is superintendent at the quarry. MINE & QUARRY is indebted to Mr. Douglas Muir and Messrs. Bartlett & Ranney, Inc., consulting engineers of San Antonio, for the information and photographs used in this article.

STEEL SHARPENING METHODS AT REPUBLIC, MICHIGAN

BY AUGUST FREEMAN*

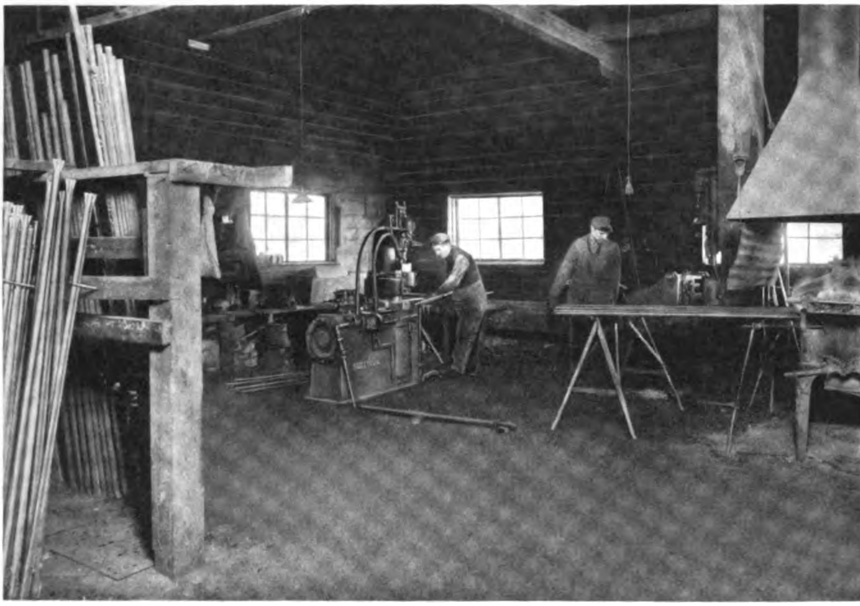
To begin with, I will give you a detailed synopsis of our equipment at the Republic Mine, which consists of one Sullivan Sharpener fully equipped with sharpening and shanking dies, two Brady No. 10 coke furnaces, an oil bath for tempering shanks, a water tank for the tempering of bits, and a small chipper machine for opening the holes in the hollow steel which we use exclusively at this property.

We also use and recommend a power saw for cutting off all new steel. This method of sawing the new steel means economy in several respects: First, it saves time, for a man can set the steel in the saw and while the saw is cutting, he can devote his time to other duties about the shop. Second, it gives you an absolutely square and smooth end, and saves further time as it does not require heating and trimming ends, before shanking, for under the old method of cutting cold, the steel would break off, leaving a slivered end to be re-cut and thrown into the scrap pile.

It must be borne in mind by all readers of this article that the writer is using nothing but hollow steel in his operations, so kindly do not compare this article with solid steel operations which are much simpler.

The drill steel in use at this property is 1⅛-inch round hollow. This steel is cut up into ten different lengths from two to eight feet long. The shanks, which are the same size as the steel (with two lugs on), are then made. This is done in two operations in our sharpener. The shanks

* Foreman, Smith Shop, Republic Mine, Cleveland Cliffs Iron Co.



Blacksmith Shop of Cleveland Cliffs Iron Company, Republic, Michigan; Sullivan Sharpener in background.

are now ready for hardening in the oil bath.

With the shanks finished the drill is taken to the heating furnace where the other end is heated and the cross-bit shaped out from the same bar of steel, all welding being eliminated.

The finished drill is now allowed to cool, after which it is transferred to the tempering furnace where it is re-heated and tempered in water.

The ten different lengths of steel now finished into drills constitute what we call one set of drills. The starter is a bit of 2½-inches in diameter, two feet long, and the finishing bit is 1⅜ inches in diameter, eight feet long, leaving a clearance of ⅛-inch on each intermediate drill.

This shop is located about midway between what is known as the Pascoe Shaft and No. 9 shaft, so that the handling of drills back and forth between shafts and shop is dependent upon some mode of haulage. This work is done by a two-ton Sternberg motor truck, which is driven into the shop and deposits its load in front of the furnace. In unloading the drills, each size is set on end in a rack provided for that particular size within easy reach of the man heating the steel.

We handle on an average in this shop five hundred drills in a working day of ten hours. In a trial run of four hours and fifteen minutes, on the Sullivan Sharpener, the writer, with the assistance of one helper who did the heating, made a run of four hundred bits without any attempt at a record or special sorting of drills.

A NEW COMPRESSOR BULLETIN

Sullivan Tandem Compound Corliss Compressors, Bulletin 75-F, 32 pages. Contains description and many illustrations of the Sullivan Class "WC," Corliss tandem compound steam, and two stage air compressors. New edition.

DRILLING LONG BOLT HOLES IN LOCK WALLS

BY D. H. HUNTER*

Lock No. 1, Brazos River, Navasota, Texas, showing method of drilling bolt holes for tying the walls together.

Some interesting work was done late last fall and in the early winter by the United States engineers at Lock and Dam No. 1 on the Brazos River, Navasota, Texas. This consisted in drilling flat holes from 12 to 17 feet in depth, through the concrete walls of the lock and in placing reinforcing rods through these holes to tie the walls of the lock together.

This lock and dam were built as a part of the Government enterprise of making this stream navigable for vessels of light draft. After completion it was ascertained that the water pressure on the inside of the lock was so great as to crack the bottom of the lock, due to the loose character of the earth supporting the walls on each side. The lock is 55 feet wide. It was, therefore, proposed to strengthen the lock walls by the methods outlined above. The problem consisted in selecting means to drill the long, flat holes required.

Reciprocating drills mounted on tripods were considered, but objection was raised to them on account of the first cost of the equipment and the necessity for making foot holes in the bottom of the lock for the legs of the tripods. It was also considered that the drilling could not be done as near the bottom of the walls as desired. Reciprocating drills mounted on quarry bars were also suggested, and the suggestion discarded for similar reasons. Drilling engineers of the Sullivan Machinery Company then suggested the use of Rotator hammer drills, equipped with a cradle or shell mounting complete with feed screw and mounted on the arm of a 2½-inch single screw column. This method was adopted. As shown by the photographs accompanying this article, one end of this column was braced against the wall on which the drilling was being done, and the other end against the end of a telephone pole, which stretched across to the opposite wall of the lock.

The work of drilling was accomplished very successfully, the holes being true and in line. The material encountered was concrete made of limestone rock. Forty-four holes were drilled, some to a depth of 12 feet and some of them 17 feet. Thirty-eight of the holes were begun with a gauge of three inches, finishing at 2½ inches; six with a starting gauge of 3½ inches, finishing at 2¾ inches. The longest length of steel employed was 20 feet. These holes were drilled at a slight angle above the horizontal, about one foot in twelve. Seven-eighths-inch, hollow hexagon steel was employed, using a six-point rose bit. The drills were placed about four feet back from the wall, and were operated by compressed air at 80 to 100 pounds pressure. The holes were cleaned of their cuttings at first by air only, using a hose with a small pipe long enough to reach to the bottom of the hole, and connected with the air line. Later a more satisfactory arrangement was employed; the hose being connected with a pump and a jet of water kept in the hole all the time. The

*San Antonio, Texas.

Detail View of Sullivan Rotator and Mounting in Brazos River Lock.

drilling proceeded faster with this assistance. The 12-foot holes were put in in about one hour and a half with the aid of the water jet, the 17-foot holes in about two hours' drilling time. Two men were used with each of the two drill outfits.

In addition to the horizontal holes above described, additional holes were drilled, starting about three feet above the lower end of the long holes at as sharp an angle as possible, and intersecting the long holes about two feet inside the face of the wall. The drills were held by hand for this work. When these holes were completed they were used for grouting in the tie rods.

Two-inch wrought iron rods with turn buckles were then inserted and tightened up after the grouting had set. The work proved entirely satisfactory and the lock is again being used for its regular purpose. The above information is furnished by Mr. C. V. Brainard, engineer in charge, under the direction of Lieut. Col. Barden of the U. S. Engineer Office at Dallas, Texas.

MINING ANTHRACITE COAL WITH HAMMER DRILLS

By Arthur E. Blackwood*

About 18 months ago, on account of the departure of many miners and laborers from the anthracite field, an engineer associated with the writer suggested the adoption of machine drilling as a means to offset the loss of production, and also make the work easier for the men, thus inducing them to remain.

He also realized that a great many of the big veins had been worked out and the present mining must be done from low veins, some of which could not be worked at a profit, and that the use of the machines for drilling would cut down the cost of production.

The problem which presented itself was:

First: To get the drilling of the face done considerably more rapidly than with the old hand auger, which takes from one-half hour per hole five feet deep, in free drilling coal with ample working room, to one hour or more per hole in low vein hard coal, streaked with impurities.

Second: To get the men properly dis-

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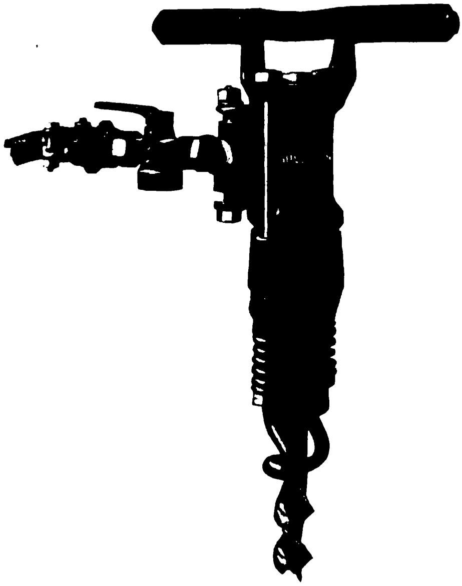


Sullivan "DR-33" Auger Rotator

tributed and the work systematized so as to obtain maximum production from the work of the air driven drill.

After experiment with several drills and several kinds of drill steel, it was found that the "DR-33" Sullivan Auger Type Rotator Hammer Drill, which has a rapid rotation and light blow, was satisfactory, and the five-foot holes were put in at the rate of 5 minutes each, as against 30 minutes for the hand auger drill, thus taking a total of 50 minutes for the 10 holes across the 30-foot face, instead of 300 minutes (5 hours) as formerly.

The working out of a system to get maximum efficiency from the miners and laborers, when using hammer drills, was accomplished through the co-operation of the manager of one of the mines, with the result that machine drilling is now recognized as a workable and profitable system of mining low vein coal in the anthracite field, as it

Increases the production per man;
Decreases cost of production;
Gives opportunity to systematize operation.

The success or failure of a drill, especially when installed for some new class of work, depends to a great extent upon the steel and form of bit. The solid spiral steel, of diamond cross section, with the fish-tail bit of 1¾-inch gauge for dynamite, while perfectly satisfactory for drilling clean coal, was not at all satisfactory if the coal had impurities, such as slate and bone, as the wings of the bits broke off. This was also found to be the case when drilling clean coal with a bit gauge of 2¼ inches to 2½ inches for black powder.

A cross bit overcame these difficulties, but as the steel furnished with fish-tail bits did not have sufficient stock to make a good cross bit, the bit was made from heavy material and welded to diamond section steel. The engineering department of the writer's firm then studied the matter and designed what is called "Heavy L" section, on which a cross bit is formed without welding, and this steel performs the work satisfactorily.

AIR SUPPLY FOR DRILLS

In mines equipped with a central air compressor plant the prevailing air pressure at the working face is around 70 pounds, which is not high enough for the best results from the Auger Rotator, as this machine accomplishes far more work with a consequent lower cost per foot of hole drilled under air pressure of 90 to 100 pounds.

It is, therefore, important to consider carefully the air pressure available when working out a new installation. If the pressure is low, it will pay the mine management to install a portable underground air compressor, which would be operated close to the face, and deliver air to the drill at not less than 90 pounds' pressure.

The 9x8 "WK-2" Sullivan, Motor Driven, Portable Compressor, with 25 h.p. motor will take care of the requirements in a satisfactory manner.

Electric coal drills have been tried for this work, but have not been successful, as they have to be set up on standards jacked to the roof, resulting in great loss of time in setting up and moving. They require two men to operate them.

In mines where coal cutters are used the "DR-33" Auger Rotator is employed to put in the holes for the purpose of shooting down the coal after it is undercut. These drills are usually operated from a compressor of the "WK-2" type, which is, to a certain extent, permanently installed in a chamber made for the purpose off the main gangway, and some distance back from the working faces. The air is piped to the face and the compressor is left in one location for months without being moved. The greater speed of drilling with the "DR-33" drill over the hand auger naturally means a saving, but that is not figured. The use of machine drilling for this work is for the purpose of increasing the production per man.

In general, it may be said there is no question as to the economy in using "DR-33" drills for coal mining, and very satisfactory results have been obtained wherever they have been installed.

As stated previously, the new system of machine drilling was, fortunately, first taken up with one of the managers, who gave hearty co-operation. It may be of interest to give particulars of the results obtained at the mines in question.

The physical conditions in this vein are, from the top down:

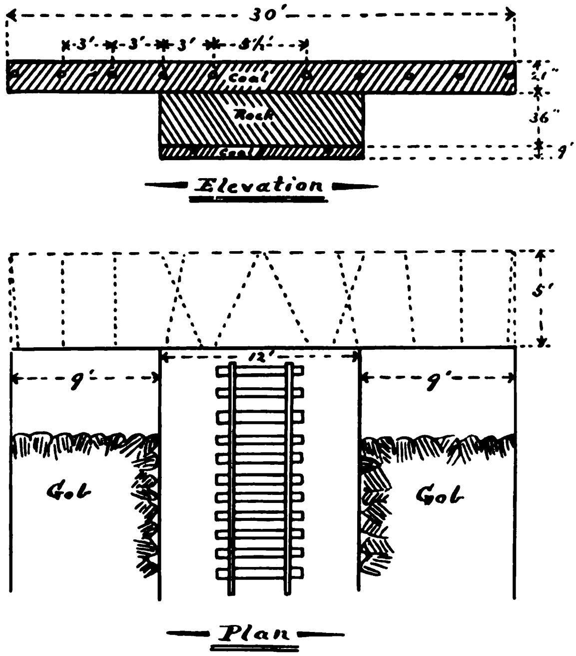
Coal, 21 inches (mined).
Rock, 36 inches (left in place except in roadway).
Coal, 9 inches (left in place except in roadway)
Total height of vein, 5 feet 6 inches.
Width of rooms or chambers, 30 feet.
Width of roadway to face, 12 feet.

Under the old system of mining it was impossible to get contractors to mine this vein on the usual basis of being paid by the car of coal produced. Consequently, the miners and laborers were put on consideration work, which means, they were paid by the day, regardless of the amount of coal turned out. One miner with one laborer was allotted to each room. The average production of coal did not exceed one and one-half cars (three and three-quarters tons) per room per shift, or three-quarters car per man. There was no system in this old method, as the miner would drill two or three holes with his hand auger drill in any location he thought best, and then load and shoot these holes. The coal was then loaded and the miner would repeat the operation of drilling and shooting a few more holes. After doing this several times, the rock bench over which the coal had been removed would become too long for them to load the coal easily. Consequently this rock had to be drilled, shot and gobbed from the roadway so that the car could again be advanced to the face.

It was impossible to institute a system whereby all the holes across the face were drilled before shooting, as men objected to spending the whole day (the time required for the full set of holes, when using the hand auger) in drilling in the cramped space of twenty-one inches.

On the 1st of April, 1916, the Auger Rotator was brought to the attention of the manager of this mine, and after two weeks were spent in trying out the drill to ascertain its capacity with their runners, four drills were purchased and the new system of "machine drilling" inaugurated. This new system is shown by the accompanying illustration (page 1006).

Twelve holes in all are drilled in the face, ten of these being in the middle of the top twenty-one inches of coal and two in the bottom in the nine inches of coal under the rock. The center or cut holes at the top are about five and a half feet apart and six and a half feet deep. The other top holes are three feet apart and five and a half feet deep. The four top



Plan of Machine Drilling System in an Anthracite Mine.

holes, nearest the center, are put in by the men holding up the drill; but this is not a difficult task, as it only takes five minutes for each hole. The remaining six holes are drilled with the machine resting on an old dynamite box, which in turn rests on the rock bench. This box is about ten inches high and brings the holes in the right position, namely, in the center of the coal. As there is no cover on the box, the drill is turned to exhaust into it, thus preventing the dust from blowing into the men's faces.

After all drilling is done, the cut holes are shot first, then each pair of relievers in turn. This method of shooting has been found to bring out the larger part of the coal to the center of the room, making it easy to load into the car. When the coal has been loaded out, the two bottom holes under the rock are fired. The rock gobbed along the sides of the road, and the coal under the rock, (nine inches) in the twelve-foot roadway only, is then loaded. On each side of the roadway the nine inches of bottom coal is not mined, as it would not pay to remove the rock overlying it.

Two men are required to operate the drill, a runner and helper. The former spots the holes and guides the drill, while the helper attends to the changing of steel, two steels being used for six-foot holes. With one man on a drill in this twenty-one inch space, it was found double the time was required to put in the holes because of the difficulty the runner had in moving around. With each drill is associated a "gang" consisting of:

One drill runner
One drill helper
Two shot firers
One timberman
One rock laborer

Three rooms are allotted to this "gang" and the coal from a five-foot advance in each room is produced every shift, the result being a total of nine cars per "gang" per shift. The coal is loaded out by contract laborers, three being required to load the nine cars per shift.

The "gang," consisting of six men, together with the three loaders, making a total of nine men, produces nine cars, or one car per man per shift under this "machine drilling" system, as against three-quarters car per man per shift before the "DR-33" drills were installed. The average cost per car, under the new method of "machine drilling" was $1.21 per

car less than under the old system. In figuring the "machine drilling" costs, all repairs and steel are included, but as the air was supplied from a central air plant which is used to operate pumps and hoists, it was not included.

From the above figures, showing a saving of $1.21 per car, or $10.89 per shift, producing nine cars, the drill will have more than paid for itself in thirteen shifts, or four and one-third days, as three shifts per day are worked.

Under old conditions this vein was mined at a loss, but with the new system, which the Auger Rotator has made possible, this vein is worked twenty-four hours per day, not only at a lower underground cost per car, but also with a lower overhead charge on account of the increased tonnage, and is now being mined at a profit.

DIAMOND DRILL TEST BORINGS FOR ENGINEERING WORK

By John A. Wentz*

I shall endeavor to show in this article the reasons why modern engineering practice requires thorough testing of ground materials at the sites of dams and bridges for foundation purposes; and will give a few instances of testings of this sort with the diamond core drills. Instances will also be given to show what has happened when dams and bridges have been built without any proper testing of this character.

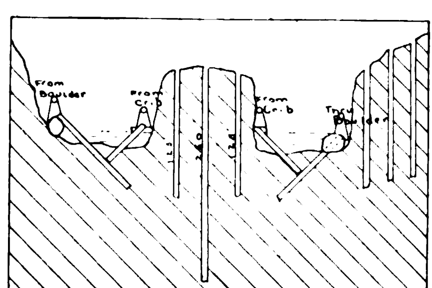
ENTERPRISES SAFEGUARDED BY TEST BORINGS

At the site of the Great Arrow Rock Dam, completed about three years ago by the United States Reclamation Service, some eight miles above Boise City, Idaho, on the Boise River, an entire year was occupied in making test borings with the Sullivan Diamond Core Drill, to find a suitable location for the foundation of the dam. In all, sixty holes were put down to various depths.

In 1913, the Little River Power Company proposed building a modern dam of large proportions across the Little River at Lookout Mountain in Alabama. In order that no uncertainty might exist regarding the solidity of the foundation, five diamond drills were ordered and furnished by the Contract Drilling Department of the Sullivan Machinery Company, of Chicago, and some seventy-five holes were put down upon various crossings. These holes ranged from 100 to 550 feet in depth, making a total of 6400 feet of drilling, at an approximate cost of $25,000.00.

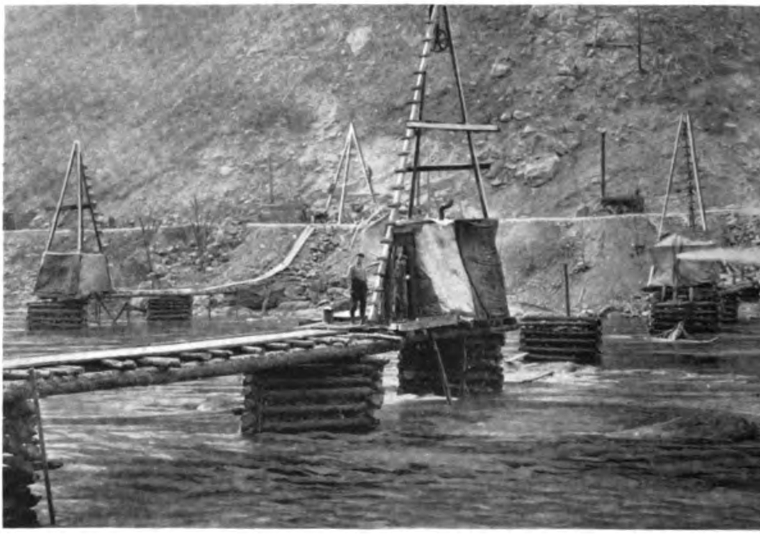
In 1910, the Portland Railway, Light and Power Company, of Portland, Oregon, had in mind the construction of two large dams on the Clackamas River, near Oregon City, in addition to one already in operation. The first step taken was to employ diamond core drills in the selection of sites at which the foundation rock would be sufficiently solid to carry the dam structure; also at which the least excavation would be required. With the knowledge gained by this drilling, it was possible to carry on the construction to much better advantage and at a great deal lower cost than if the rock conditions had not been developed by this method.

The Chicago & North Western Railway owns a Sullivan Diamond Core Drill,



Diamond Drill Borings for a Dam Site on the Clackamas River, Oregon

*Chariton, Iowa.



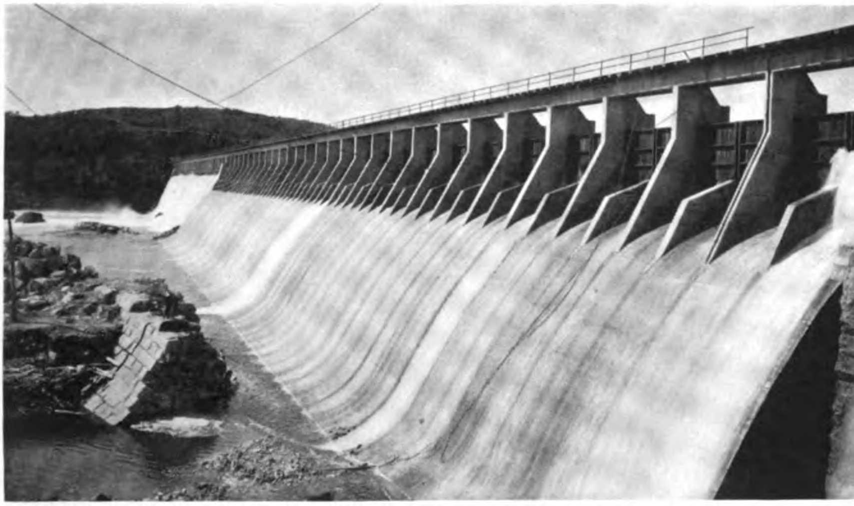
Four Sullivan Diamond Drills testing bed of Little Tennessee River at Chilhowee, Tenn., for site of Knoxville Power Company's dam

which is used from time to time by the bridge engineering department in selecting suitable locations for bridge piers on its larger bridge construction jobs. The location for the bridge across the Missouri River at Pierre, S. D., was selected in this manner, the test boring work being done during the winter when the drill shanty could be set up on the ice. The Sullivan Diamond Drill was used again in making numerous test borings at Clinton, Iowa, for the present North Western bridge across the Mississippi River. Well drills had previously been used at this site and a profile of the river bottom drawn up to show the line of solid rock indicated by these borings. Verification of this work with the diamond drill showed that the well borings were inaccurate, as they had indicated solid rock at points where the rock was in reality only a projecting shelf. The actual line of solid rock was found to be considerably lower as a result of the core borings taken with the diamond drill.

Many other instances could be mentioned to show that modern engineers refuse to take chances or trust to luck in construction work of this type, on which the character of the material underlying the foundation has so much to do with the permanence of the project in view. Numerous cases are on record in which, as a result of insufficient investigation, dams have been built on what appeared to be solid rock, but which events proved to be only thin layers of stratified material with softer beds below. When the full pressure of the water storage was exerted the dam has given away and been carried down the stream.

EXAMPLES OF FAILURES

The City of Austin, Texas, had an experience of this kind a few years ago. The foundation of the dam, constructed for water supply, gave away, and the structure was carried down the stream and broken up. In 1907, test borings carried on by the Sullivan Machinery Company, under the direction of the engineer, Mr. Walter G. Fitzpatrick, showed that the dam had been built on a thin bed of lime-



The present Austin, Texas, dam on the Colorado River. At the left is seen a fragment of the old dam wrecked by floods on account of location on insecure materials. It cost $1,720,000 to replace the dam.

stone, under which was soft shale, badly faulted. After the old dam had been in use for some time, the undermining action of the water advanced to a point at which the entire structure was ruined. On the Missouri River near Helena, Montana, the Hauser Lake Dam, a structure of the hollow steel pattern, failed from similar causes, as was fully demonstrated by the diamond drill, which was extensively used after the failure took place and by means of which a safer location was then selected upon which a dam of approved permanence has been erected.

In comparison with the terrible damage and the enormous money loss, which may be occasioned by the failure of a dam or bridge due to unsafe foundations, the amount of money required for adequate exploration before the structure is begun is insignificant, and frequently the far larger amount necessary for construction would not be expended if test borings were made with the diamond drill, and showed that the enterprise, at the site selected, would be doomed to failure and loss.

NEW ROCK DRILL BULLETIN

SULLIVAN ROCK DRILLS, Bulletin 70-D, 48 pages, loose leaf. Describes the Sullivan Lite-weight and Hy-speed reciprocating piston rock drills in full detail, also Sullivan tripods, columns, gadders, quarry bars, drill steel, hose, tools, etc.

Diagram of test boring for Chicago and North Western R. R. Co. Bridge on the Mississippi River at Clinton, Iowa

The dotted line shows supposed bed rock, as disclosed by borings made with a churn drill. The solid line is real bed rock, proved by the Sullivan Diamond Drill.

A PNEUMATIC PUNCH FOR HOLLOW DRILL STEEL

STAFF ARTICLE

Sullivan Drill Sharpener equipped with Sullivan Hammer Punch for punching out hollow steel.

The accompanying illustrations show a clever device recently adapted for attachment to the Sullivan drill sharpening machine, to permit rapid and convenient punching out of the hole in hollow drill bits and drill shanks. Blacksmiths know that the action of upsetting hollow drill steel and of forging it tends to close the hole, so that some means is necessary for opening it again to its full size. Various appliances have been developed for this purpose in order to save the time required to use a hand punch. The dolly pin operates satisfactorily in some cases, particularly on the smaller sizes of steel, or when the work to be done is not of a kind that will close the hole seriously. A special pneumatic punch has been used with good effect; but this is rather an expensive and elaborate apparatus to install for this little job. As shown by the accompanying illustration, a Sullivan "DB-13" Air Hammer Drill, such as is used frequently for hitch cutting and trimming, is the tool employed in the present device. This tool weighs 14 pounds. Its two essential features are a push throttle handle and a nose chuck with a knurled or milled cap, which is screwed to the end of the cylinder to hold the drilling tool in position. The tool is supplied with a collar forged on the shank to prevent it from being pulled out of the chuck.

As will be noted from the illustrations, the drill is placed at the back of the sharpener on a special clamp or brace bolted to the frame for this purpose, and so arranged that the handle of the tool is permanently held while the cylinder is left free to slide back and forth on a support. The method of using the tool is as follows:

The bit is forged and sharpened first in the usual manner. The operator then places the bit end of the steel over the end of the punch, which is inserted in the chuck of the "DB-13" tool. A slight thrust by the operator opens the throttle and starts the tool reciprocating so that the hole is quickly opened to full size. When the punch has advanced far enough into the steel, a quick pull releases it. Some punches have been made up with a blunt end, with the diameter of the punch reduced just back of the point. This is said to give better results in removing the steel from the punch. In some cases operators have elaborated the bracket for holding the "DB-13" tool by adding a guide arm in front on which the steel can be rested when thrusting it onto the punch. This is said to save time in handling.

This special attachment will be regularly furnished on any Sullivan drill sharpening machine and when so furnished, the tool is equipped with a special handle and is permanently placed in an opening cut

in the vertical frame for it. The present illustrations are of a home-made form of bracket, which can be adapted for attachment to any sharpener in the field. The economy of time and labor involved in the use of this tool has proved a very important one in blacksmith shops where a large amount of hollow steel has to be handled.

Sullivan "DB13" Hammer Drill in use as a steel punch on a Drill Sharpener.

NATIONAL SERVICE HONOR ROLL

The following employes of the Sullivan Machinery Company have engaged actively in the National Service (names of men subject to the draft not yet available):

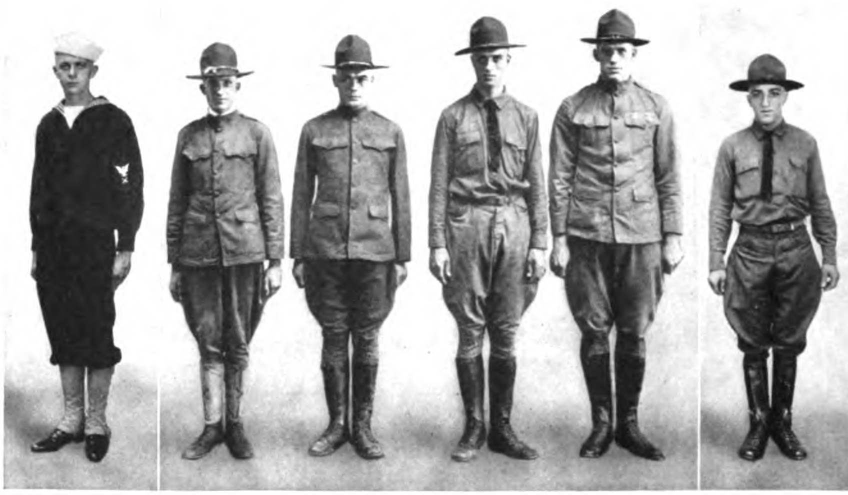
CLAREMONT, N. H., WORKS

Name — *Service*

Clarence A. Amell, N. H. Nat. Guard.
C. B. Allen, Jr., N. H. Nat. Guard.
Charles H. Berg, N. H. Nat. Guard.
William Baker, N. H. Nat. Guard.
Raymond F. Codair, N. H. Nat. Guard.
Gerald B. Croone, N. H. Nat. Guard.
John F. Cook, N. H. Nat. Guard.
Lyle L. Craig, N. H. Nat. Guard.
Florido J. DesFosses, N. H. Nat. Guard.
Peter F. Hollywood, N. H. Nat. Guard.
George H. Kittredge, N. H. Nat. Guard.
William Kelley, N. H. Nat. Guard.
L. R. LeClair, N. H. Nat. Guard.
Olivio J. LaCasse, N. H. Nat. Guard.
Frederick J. Mattoon, N. H. Nat. Guard.
Everett McCleary, N. H. Nat. Guard.
Howard E. Pierce, N. H. Nat. Guard.
Edwin E. Ridley, N. H. Nat. Guard.
Henry P. Richotte, N. H. Nat. Guard.
Stephen Royce, N. H. Nat. Guard.
Roy C. Smith, N. H. Nat. Guard.
N. J. Savoie, N. H. Nat. Guard.
Ernest Simoneau, N. H. Nat. Guard.
William Lasky, Vt. Nat. Guard.
Harold C. Potter, Vt. Nat. Guard.
Edward J. Simoneau, Vt. Nat. Guard
Ralph Bedell, Coast Artillery.
Lawrence E. Plantier, Coast Artillery.
Joseph Prendergast, Coast Artillery.
Harry F. Blake, Engineering Corps.
Cornelius G. Boudette, Engineering Corps.
William R. Hughes, U. S. Regular Army.
Harold Cleveland, U. S. Cavalry.
John Cochrane, U. S. Cavalry.
Wilfred C. Hart, U. S. Cavalry
Cleo Albee, U. S. Navy.
John Durward, U. S. Navy.
Roland Gouin, U. S. Navy.
Royce W. Higgins, U. S. Navy.
Ivan Kukola, U. S. Navy.
Francis W. Lynch, U. S. Navy.
Harold Perry, U. S. Navy.
Harold W. Pike, U. S. Navy.
Didrick Tonseth, U. S. Navy.

CHICAGO, ILL., WORKS

Sigurd A. Benson, Sergeant, 2nd Ill. Field Artillery.
Samuel Scortino, Corporal, 2nd Ill. Field Artillery.
E. Hennessey, Ill. Nav. Reserves.
Leo Barlick, Gunners' Mate, 2nd Class, Ill. Nav. Reserves.
Roy Graham, Colo. Nat. Guard.
Chas. Hastings, Mich. Nat. Guard.
James Herda, U. S. Cavalry.
Arthur Kessell, Co. "B" 2nd Inf. Ill. Nat. Guard.
Stanley Nelson, Signal Corps, 2nd Inf. Ill. Nat. Guard.
Leroy Powell Signal Corps, 2nd Inf., Ill. Nat. Guard.
Frank Roose, Aviation Corps, U. S. A.
George W. Blackinton, Denver, Colo., Senior Captain, National Army, Ft. Riley, Kan.
S. F. Greeley, Chicago, Second Lieutenant, Field Artillery, National Army.
H. C. Abbott, Chicago, Second Lieutenant, Infantry, Officers' Reserve Corps.
Edward Orth, Chicago, 7th Reg., Ill. N. G.
F. W. Copeland, St. Louis, Second Lieutenant Field Artillery, National Army.
P. W. Glover, St. Louis, R. O. T. C., Ft. Constitution, N. H.
C. G. Miller, Joplin, Mo. Nat. Guard.
R. A. Lowry, Huntington, W. Va., Second Lieutenant Engineer Corps.
C. H. Tipping, Huntington, W. Va., Second Lieutenant Ordnance Dept.
H. C. Keniston, San Francisco, Aviation Corps, U. S. Army, San Diego, Calif.



Military Representatives, Chicago Works, Sullivan Machinery Company.

From left to right:—Leo Barlick, Gunner's Mate, 2nd Class, Illinois Naval Reserves; Arthur Kessell, 2nd Inf. Ill. Nat. Guard; Sigurd A. Benson, First Sergeant, 2nd Illinois Field Artillery; Stanley L. Nelson, Signal Corps, 2nd Ill. Infantry; Leo O. Powell, Signal Corps, 2nd Ill. Infantry; Samuel Scortino, Corporal, 2nd Ill. Field Artillery.

M. J. Small, U. S. Medical Corps, San Francisco, (formerly sales engineer, San Francisco office).

Second Lieutenant Sidney F. Greeley, U S. Field Artillery, Camp Grant, Rockford, Ill. (assistant advertising manager).

P. W. Glover, R. O. T. C., Fort Constitution, N. H. (formerly sales engineer St. Louis office).

Name — *Office* — *Service*

M. J. Small, San Francisco, U. S. Medical Corps, San Francisco.

H. L. Browne, Joplin, Aviation Corps, Ft. Slocum, N. Y.

Edward Hillengass, Pittsburgh, U. S. Army.

Austin Y. Hoy, London, Canadian Field Artillery.

Harold S. Worcester, Juneau, R. O. T. C., The Presidio, San Francisco.

E. F. Burton, New York, R. O. T. C., Plattsburg, N. Y.

Ross S. Mason, Denver, Second Lieutenant, Field Artillery.

Geo. W. Haskins, Huntington, Army Aviation Corps.

R. S. Weiner, El Paso, Army Engineer Corps.

Lieutenant Frederick W. Copeland, Field Artillery, National Army, Rockford, Ill.

Lieutenant Austin Y. Hoy, Canadian Field Artillery, (formerly manager of London, England, office).

Second Lieutenant R. A. Lowry, U. S. Engineer Corps, (formerly sales engineer, Huntington, W. Va. office).

Captain George W. Blackinton, National Army, Camp Funston, Fort Riley, Kan., (formerly manager, Denver office).

Lieutenant H. C. Abbott, Officers' Reserve Corps.

H. C. Keniston, San Francisco, Army Aviation Corps.

MINE AND QVARRY

REG. U. S. PAT. OFF.

VOL. X, No. 3 FEBRUARY, 1918 WHOLE No. 34

Helping to Win the War

DRIVING THE U. V. X. TUNNEL

DRILL BITS AND STEEL, II

COAL MINING IN SOUTH AFRICA

PVBLISHED BY THE SVLLIVAN MACHINERY CO. 122 S. MICHIGAN AVE., CHICAGO.

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VOL. X, No. 3 | FEBRUARY, 1918 | Whole No. 34

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

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Readers are requested to notify MINE AND QUARRY of any correction or change in address.

MINE AND QUARRY opens another year with the resolve to be more useful to its readers than before; and to do all that it can, in its limited scope, to help win the war for democracy. Suggestions toward both objects will be welcomed by the editors.

Many former readers of MINE AND QUARRY have been called to the colors; others are constantly enlisting to play parts more or less active in the war. Those who desire to keep in touch with the mechanics of rock excavation, with air power uses, and with coal production, are urged to send us their new addresses.

Our cover illustration shows an Iron-clad Coal Cutter crossing the face in the mines of the Blue Diamond Coal Company, at Blue Diamond, Perry County, Kentucky. Ironclads, the men who operate them and the mines that own them, are helping to win the war as truly as the guns and men at the front.

The cost of mailing MINE AND QUARRY reply cards has doubled. This makes the cost of your subscription two cents a year instead of one. The editors hope they may receive more communications from readers, not fewer; and longer ones, not shorter, as a result of the increase in value of these cards. Postage will be refunded to any who desire MINE AND QUARRY discontinued and who will use the card so to notify the publishers.

In this issue will be found the second installment of Mr. G. H. Gilman's article on "Drill Bits and Drill Steel." Emphasis is placed on the relation between the size of the hole and the work required to drill it. The graphic representation of the facts stated is particularly clear. It may interest readers to know that the type of bit designed by Mr. Gilman as a result of his studies, viz., the "double-arc" bit, is securing excellent results under varying field conditions. Other papers by Mr. Gilman, to appear in later issues, will deal with the heat treatment of steel and with the arrangement and equipment of drill sharpening shops.

Sullivan "DR-6" Drills on columns in the Portal Heading of the U. V. X. Extraction Tunnel, Jerome, Arizona. The heading crew includes expert drillmen who have helped make progress records on well-known tunnels in other parts of the country

DRIVING THE "U. V. X." EXTRACTION TUNNEL

By D. J. O'Rourke *

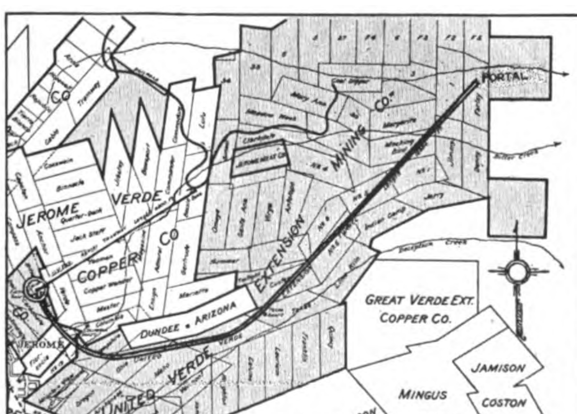
The Potter Construction Company, Railway Exchange Building, St. Louis, is driving an extraction tunnel for the United Verde Extension Mining Company of Jerome, Arizona. The object of this tunnel is to simplify the present system of handling ore from the Audrey and Edith shafts. At present the ore is dropped 4000 feet down the mountainside on an aerial tramway, into storage bins. Thence it is reloaded in cars of standard gauge, on which it is hauled a distance of about three miles over the U. V. T. & S. R. R., after which the cars are transferred to the Santa Fe system, to be hauled to Douglas or Humboldt.

This tunnel, which is 12,384 feet in length, will not only save this long haul and rehandling of ore, but it will save hoisting the ore 1100 feet from the thirteenth level of the United Verde Extension main shaft. The ore will be shipped, when this tunnel is completed, direct from the foot of the main shaft, where pockets are to be constructed for storage purposes, through the tunnel onto the Arizona Extension Railroad, on which the cars will be hauled direct to the new smelter, about three miles distant. The course of the tunnel from the United Verde Extension main shaft to the portal, which is about a mile and a half northwest of Clarkdale and two miles and a half from the mine, is shown on the accompanying plat. The grade of the tunnel is down-hill from the mine 0.425 per cent, or 22.5 feet drop per mile. The tunnel is being driven 11 feet wide at subgrade, 10 feet 3 inches wide at the spring line and 10½ feet high from subgrade. The completed tunnel will give a clearance 9½ feet high above the permanent rails to the top of the arch. A ditch 18 inches wide and one foot deep is carried at the side of the tunnel for drainage. The tunnel will be laid with 70-pound rails, and the track will be standard railroad gauge. The roadbed will be built to carry steel railroad cars with hopper bottoms, having a capacity of thirty tons, built especially for this service. Haulage will be by electric locomotive and trolley.

The tunnel is being driven from four headings, that is, from inside the mine, from the outside, or portal, end and from both headings at the foot of a shaft which has been sunk at a point 6700 feet from the portal. This is known as the Texas shaft. It is 613 feet in depth, and consists of two hoisting and pumping compartments 4 x 5 feet, and a man-way 2½ x 5 feet.

GEOLOGY

The formation through which the tunnel is being driven represents a variety of apparently unsystematically placed geological strata. In the portal end con-



Mine properties at Jerome, Arizona, showing line of tunnel

*Supt. Potter Construction Co., Clarkdale, Arizona.

glomerate was immediately encountered, and, at the time of writing, at which this heading has been advanced approximately 3600 feet, the conglomerate is still the prevailing formation. This conglomerate is an exceedingly solidly compacted mass; in fact, so tight that thus far no water at all has been encountered in the heading. The body of the conglomerate consists of eroded limestone, which acts as a natural cement to hold together fragments from the size of small pebbles, up to blocks of stone three feet in diameter; and this material includes sandstone, limestone and also igneous rocks, such as diorite, and the lava rock locally known as malapai, which is very dense and difficult to drill.

The difficulty of drilling this formation will be readily understood by those familiar with rock conditions. At the station end of the tunnel, where the heading has been driven about 1350 feet, the first rock encountered was diorite and schist. Due to the proximity of this heading to the mineralized zone of the mine, the formation was badly cut up with diagonal dykes of soft material, similar to calcite or soapstone, which required heavy timbering. If these dykes had been encountered at right angles they could have been supported by one or two sets of timbers, but, due to the angle at which the heading crossed them, it frequently required ten to twelve sets to catch them up. Timbers used for this work were 12 x 12s spaced on five-foot centers. Presence of these dykes or faults greatly retarded progress. The most interesting part of the work, geologically speaking, was encountered in sinking the Texas shaft. This was sunk at a point which, it shortly developed, was on a well-defined fault. The geologists at the mine predicted that limestone would be encountered at a depth of about 275 feet, as all indications of outcrops, stream beds, etc., in the vicinity indicated this would be the case. The shaft first ran into the conglomerate, which is the usual capping rock of the vicinity. After running through this for about 50 feet, boulders of basalt were struck, and, a little below, the shaft encountered solid basalt rock. Much of this was of a red color, resulting from the hematite bonding of the material. It did not lie in any well-defined beds, but stood on edge in irregular masses, jointed and blocky. After penetrating this material for about 350 feet, the quartz porphyry was encountered in a badly broken up condition. For a distance of about 100 feet from this point, piles had to be driven outside of the timbering to hold the ground. At about 575 feet, or some 35 feet from the bottom of the shaft, which is 613 feet deep, the soft, oxidized porphyry altered to hard, solid quartz porphyry, and the cross cut was turned in this material and driven 50 feet from the foot of the shaft to the intersection with the tunnel line.

DRIVING THE PORTAL HEADING

The portal heading was started on July 7, 1917. The footage driven since that date has been as follows:

July	300 feet
August	453 feet
September	517 feet
October	563 feet
November	581 feet
December	640 feet
January	614 feet

This makes a total of 3668 feet, or an average of 524 feet per month.

Considerable delay was encountered in making satisfactory progress in this ground at the start, due to the difficulty of getting holes to depth in the formation. The first method of drilling tried was by means of self-rotating hammer drills, holding the machines by hand for some holes, while for others the drills were mounted on cradles and feed screws on columns. Four drills were used in the heading at one time, and holes eight to ten feet deep were drilled. Seven-eighths-inch hexagon hollow steel was

used with cross bits. The drills were of the water type, by means of which a water and air jet was forced to the bottom of the drill hole to clean it of its cuttings.

After driving 90 or 100 feet with the rotators, it became evident that the use of mounted drills entirely would give better satisfaction on account of the difficulty in keeping the holes in line when running through the uneven formation. It was also decided to substitute heavier machines for the rotators, and the Sullivan "DR-6" Water Jet Mounted Hammer Drills, with 2½-inch cylinder and weighing 150 pounds, were adopted. For a considerable period the heading was advanced with two "DR-6" drills mounted on double-screw mining columns, the drills being carried by means of extension arms, enabling the drill to work 36 inches from the column in drilling the side holes to follow the contour of the tunnel.

DEEP HOLES DRILLED WITH "DR-6'S"

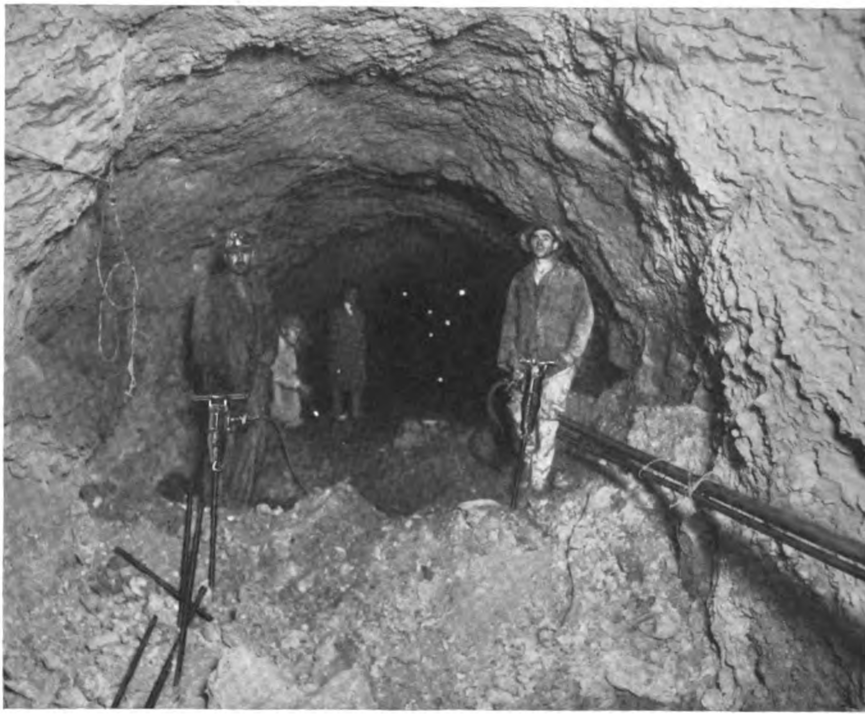
It was later decided to increase the depth of the holes from 10 to 13 feet, and a third drill was added to advance the rate of progress. The advantage of using holes of such great depth for the cut is demonstrated by the success with which the ground was pulled after the change was made. Six cut-holes are used. The solidity of the bonding of this conglomerate material will be shown by the fact that with the 13-foot cut-holes, 7 or 8 feet of the cut are often thrown out by the first shot in a practically solid mass of wedge shape, requiring reblasting, before it can be mucked. The cut-holes are then loaded again, and reshot before the side round is fired. If any of the cut is still left after the second shooting, it is again loaded and shot, with the side round. The explosive used in the cut-holes, which gives excellent satisfaction, is Atlas Blasting Gelatine of 60 per cent strength. Atlas Gelatine of 40 per cent strength is used to blast the side rounds and roof holes. The side round and roof holes are fired at the same time, delay exploders being used for the roof, which is thus thrown out after the side round has gone. No relieving holes are used, as it was found that the heavy charging of the cut-holes occasionally caused ignition of the charge in the relievers at times when seams were being crossed. Four rib holes are put in on each side of the tunnel, four holes in the roof, and four lifters, making a total round of 22 holes. The roof and side holes are of approximately the same depth as the cut-holes.

This tunnel is being driven, as indicated by the sketch, page 1019, by the top heading and bench method, the work being divided between a 7-foot heading and a 3½-foot bench. The bench is kept within about 30 feet of the heading at all times, and is drilled with Sullivan "DP-33" Water Tube Rotator Drills, using ⅞-inch hexagon hollow steel with cross bits. Holes are drilled with these machines to a depth of about 5 feet to insure reaching the subgrade of the tunnel.

DISPOSAL OF MUCK

Telescopic bars or braces are placed across the tunnel, just above the grade of

Portal of U. V. X. Tunnel, Clarkdale, Arizona. D. J. O'Rourke, Tunnel Superintendent, at left; two of the 14-foot steels used in the heading round are shown at the right



Drilling the Bench, U. V. X. Tunnel, with Sullivan Rotators

the bench, at a sufficient height to permit the tunnel cars to run below them. Planks are laid on these supports, serving as a runway for the barrows in which the muckers remove the material from the heading, and from which it is dumped into the muck cars below. The bench muck is shoveled direct into the cars. The tunnel is laid with double track of 12-pound rail at the heading, the switch being moved forward every two weeks, and passing tracks are installed about 1200 feet apart. Steel side dump cars having a capacity of 32 cubic feet are employed for handling the muck. These are the same type and size of cars as those used on the Los Angeles Water Works tunnel some five or six years ago. Mule haulage is used, the mules coming right up to the end of the scaffolding, which is within 30 or 40 feet of the bench, so that practically no hand tramming is necessary. One mule hauls two cars at a time.

ORGANIZATION AND WORKING PLAN

Two eight-hour shifts are worked. The mucking gang, consisting of twelve muckers and a foreman, commence work at 8 A. M. Three hours are required to load out the muck from the previous shot at the face of the heading, so that when the miners come to work at 11 o'clock they are able to set up the columns and start drilling the new round. Two men are used on each machine in the heading. Under favorable conditions the heading round is completed by 3:30 or 4 o'clock, and the round is then shot, so that ample time is allowed between shifts for blowing the smoke. Two ro-

tators, each operated by a single man, drill the bench. The next, or night, mucking shift comes on at 8 o'clock in the evening and the miners again at 11.

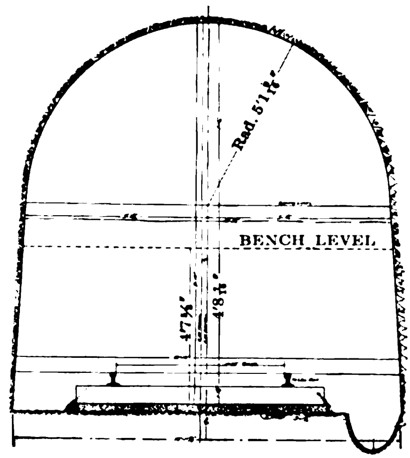
RATE OF PROGRESS

As will be noted above, the monthly progress, including the short month in July, has averaged better than 500 feet. During the month of December, 640 feet were driven. With the length of holes finally used, it has been not at all unusual to secure a progress of 25 feet of heading in 24 hours (two shifts). Fifty-eight shifts were worked during December to give the progress mentioned above.

STATION HEADING

As stated above, about 1350 feet have been driven from the inside or station end of the tunnel. The problem at this heading was not one of drilling speed, but of adapting the work and organization to the organization of the mine. As described above, in all, about 300 feet of 12 x 12 timbers had to be set. This was a costly operation, as weaknesses in the rock frequently developed after they had been passed for some distance, and it was necessary to delay operations until the weak spot could be widened out and the timbers set. All muck from this heading has to be handled through the main hoisting shaft of the United Verde Extension mine, or carried back into empty stopes. The cars are handled by tail rope haulage. Trouble was also experienced in blowing out the tunnel after blasting, so that special means for ventilation had to be devised. Finally it became necessary to draw a fresh air supply from the Edith shaft, on the thirteenth level, by means of 12-inch pipe, the exhaust system being used to suck the air in from the Edith shaft by a No. 8 Buffalo blower.

Due to the conditions mentioned above, it was found that a rate of advance of between five and six feet per shift was



Cross Section of the U. V. X. Extraction Tunnel

as great as proper disposal of the muck would allow. The sketch, page 1023, shows the tunnel round in this heading, which is practically the same as that at the portal heading, except that relieving holes are used to secure better distribution of the powder and break up the muck smaller. Two Sullivan "DR-6" Drills mounted on extension arms on double-screw mining columns are used in this heading also for drilling the heading round. The bench is drilled by means of lifter or horizontal holes put in from a cross bar by the heading crew after they have drilled the heading round. The "DR-6" drills are mounted on a bar for this purpose and seven-foot holes are the rule. The bench is carried up to within a few feet of the heading, and all muck from the heading thrown over the bench. The material from the heading and bench both is loaded directly into the mine cars.

SINKING THE SHAFT

The shaft described above, 613 feet in depth, and 5 x 10½ feet in area, was sunk entirely with Sullivan Water Tube Rotators, of which four were employed. Pressure for the water jet was obtained by gravity from a sump at the

Head-frame, Dump and Yard, at Texas Shaft, U. V. X. Tunnel

a sump being prepared for it. For the next 50 feet no water was encountered, but at that point another pump had to be installed, which lifted the water to the sump, from which it was pumped to the surface Two duplex Prescott pumps, size 10x5x12, were employed for this work and proved very successful. This wet condition prevailed until the bottom of the shaft was reached.

350-foot level and from the surface, down to that point. In sinking, the shaft holes were ordinarily drilled to a depth of seven feet. It was necessary to carry the timber quite close as the work progressed, and, under ordinary conditions, about one set of timber was placed per day, on 5½-feet centers. The round of holes averaged 16, and these holes were shot electrically with three sets of delay exploders, the cut-holes being fired first, then the first set of side holes, and so on. This method of shooting was entirely satisfactory and much safer and more reliable than fuse, which was tried at first. Work on the shaft was started June 21st with a hand windlass. On July 15th operations were commenced with a hoist and head frame which had been erected over the shaft, shown in the picture on this page. The hoisting engine was furnished by the mining company. One 4 x 5 foot compartment is used for hoisting, the second for pumping, and the third (2½ x 5 feet) is used as a manway.

Water was encountered at a depth of about 175 feet from the surface, and gave considerable trouble. A station had to be cut at a depth of 350 feet and the water from above was led into it,

POWER PLANT

The power plant for the outside heading is located close by the portal, and consists of the following equipment—

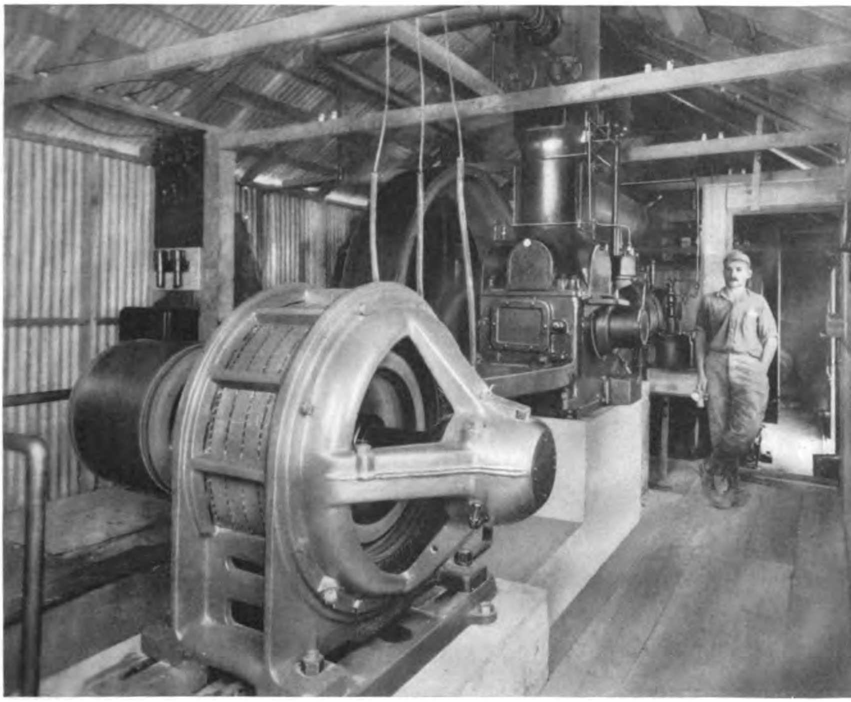
1 Sullivan Angle Compound Belt Driven Air Compressor, Class "WJ-3," size 16 x 9¾ x 12 inches, with a capacity of 628 cubic feet free air per minute at sea level. This is driven by a 100-h. p. General Electric motor. The current is obtained from the Arizona Power Co., by arrangement with the mine.

1 450-foot Cross Compound Belt Driven Compressor, driven by a 75-h. p. motor.

1 Sullivan Drill Sharpener, with full equipment of dies and dollies for making the cross-bits on hollow steel for the ⅞-inch rotator steel, for the 1¼-inch round, hollow "DR-6" steel, and for the shanks on these two types of drills.

LOW CENTER, DOUBLE-TAPER BITS

The bits are heated in a Denver Fire Clay Company's oil forge, and are heated for tempering in the same furnace. The blacksmith shop, showing the sharpener, forge, and tempering tank are shown in the picture on page 1022. The bits used are interesting, being of the four-point or



Sullivan Angle-compound Compressor used for operating the drills, Portal Heading, U. V. X. Tunnel

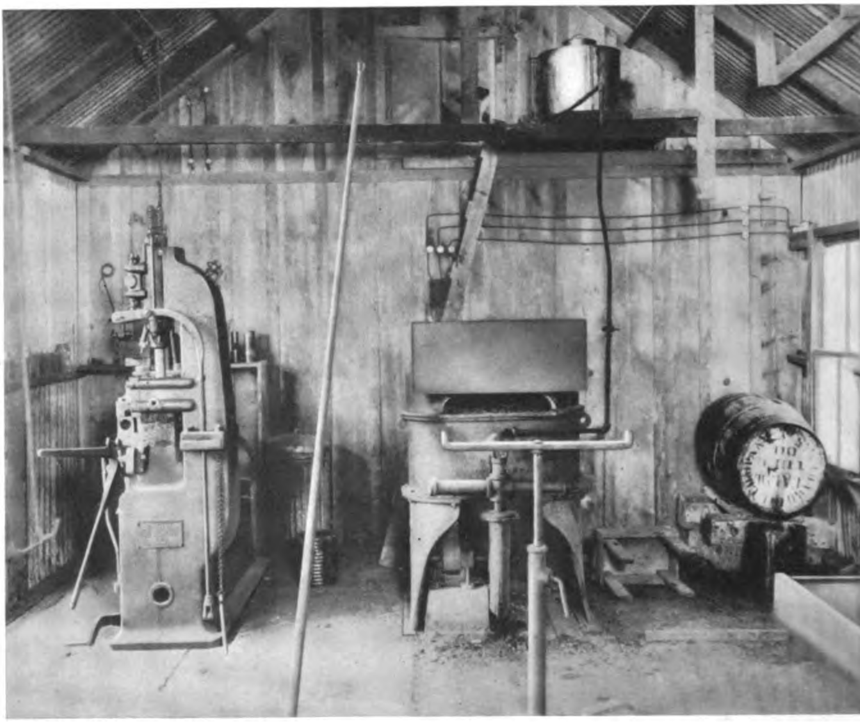
cross type, with low center, and double taper on the wings. The wings, for a distance of one inch back from the face, have a 5-degree taper; with the usual 14-degree taper from that point to the base of the wing. In the difficult conglomerate formation mentioned on a preceding page, this double taper gave a very good reaming effect as will be seen from the fact that it is very seldom that a steel has to be changed on account of lost gauge before the end of the run is reached. The low center bits secure the advantage that holes rarely drift as they would otherwise do frequently, due to the different angles at which the boulders are encountered. The high corners catch the hole on the sloping surface of the boulder. At the inside heading, air is of course taken from the regular mine supply. A Sullivan Drill Sharpener and Case forge are also installed at the mine end at the top of the shaft. Two cross compound belt driven compressors were furnished by the mine for the Texas shaft, one having a capacity of 1000 feet, and the other 450. Steel for sinking the shaft was furnished from the sharpener at the portal for practically the entire distance. The shaft was bottomed on December 24, but, of this time—from June 21—about one month was lost due to machinery delays.

Acknowledgment is made to Mr. A. Syverson, engineer of the mining company, for assistance in securing the illustrations and data used in this article.

ORGANIZATION AND PERSONNEL

[By the Editor]

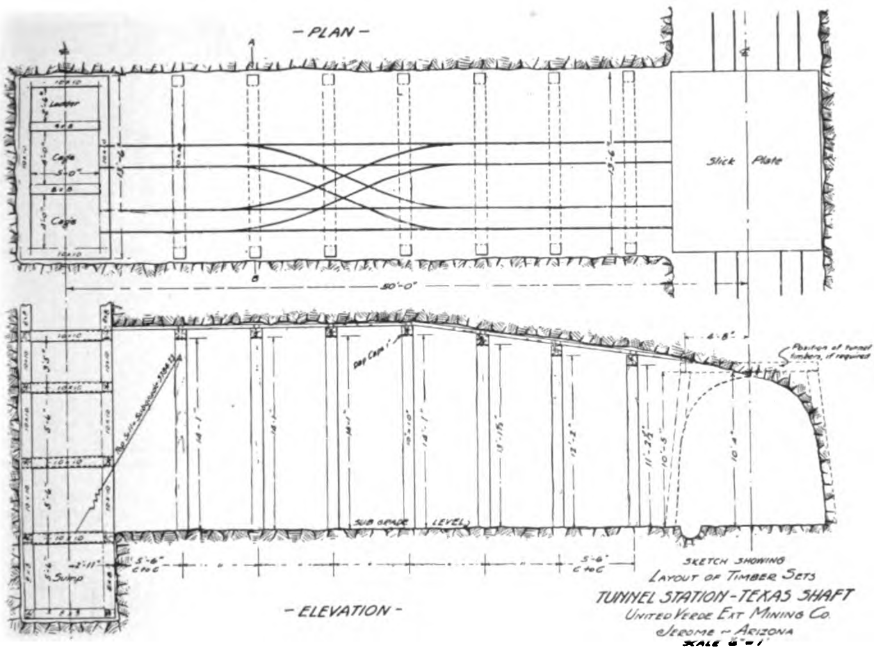
Mr. Daniel J. O'Rourke is in immediate charge of the tunnel driving operation and has personal direction of the portal



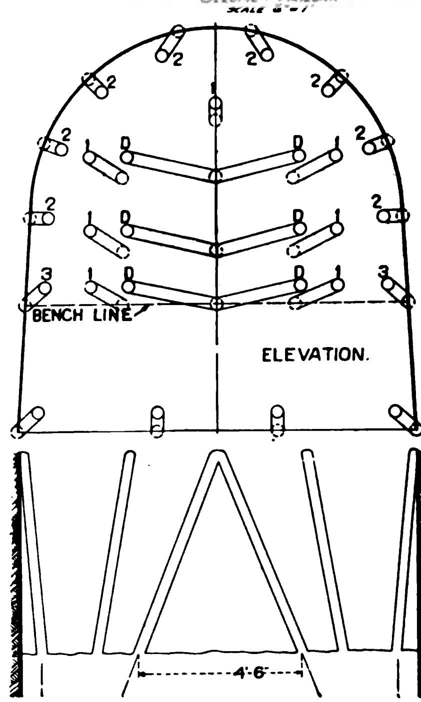
Blacksmith shop of Potter Construction Company, at Portal Heading, U. V. X. Tunnel. Sullivan Drill Sharpener at left, oil forge in center, tempering tank at extreme right

or outside end of the tunnel. He has associated with him his brother, James E. O'Rourke, who is driving the inside or station heading. Both of these men are rock drilling experts of many years' experience, having spent most of their lives as shop and field men for the Sullivan Machinery Company in the manufacture, use and direction of Sullivan Rock Drills, Hammer Drills and Stone Channeling machines. Mr. D. J. O'Rourke has had the personal direction and maintenance of the drilling equipment on such enterprises as the Mount Royal Tunnel of the Canadian Northern Railroad at Montreal, Quebec, which three or four years ago was driven in record time by the use of Sullivan Water Drills; the first East River Tunnel of the Pennsylvania Railroad between New York City and Long Island City; and the Mill Creek Sewer Tunnel at St. Louis. Mr. Jas. E. O'Rourke left the position which he had held for some two years past as superintendent of ground breaking and underground mining work for the American Zinc, Lead and Smelting Co., to join his brother in this tunnel undertaking. They have gathered an organization of expert drill men, timber men, etc., and to their ability to secure and hold this class of workmen is due much of the success with which they are conducting this enterprise.

The progress on the portal end of this tunnel compares favorably with any similar work which has been done in recent years, considering the difficulty of the ground, the size of the heading and the length of the haul. The four-hour gap between the two shifts enables



Texas Shaft, U. V. X. Tunnel; Engineer Syverson, at left. D. J. O'Rourke, at right



Station Heading Drill Round, U V. X. Tunnel

all traces of powder smoke to be removed and the tunnel is kept well ventilated at all times.

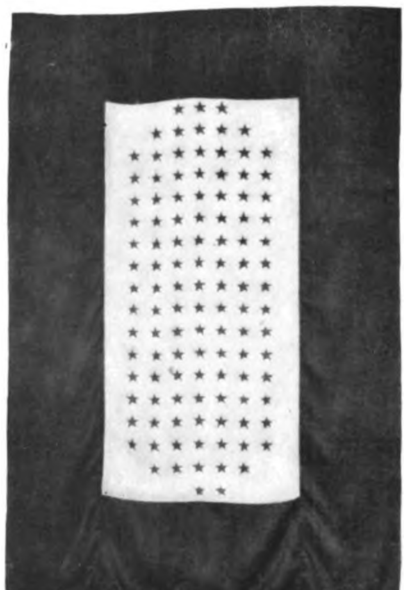
F. E. O'NEIL
Chicago
Base Hospital, Camp Grant, Ill.

LIEUT. C. B. OFFICER
Claremont
Coast Artillery,
France

CAPT. M. R. BLISH
Denver
Ordnance Dept.,
South Bethlehem, Pa.

D. P. O'ROURKE
Engineer Corps,
U. S. Army

M. J. PONTIUS
Chicago
U. S. Naval Reserve,
Great Lakes, Ill.



One hundred and thirteen stars are on this Sullivan Service Flag, which hangs in the general office of the Sullivan Machinery Company at Chicago

C. G. BOUDETTE
Claremont
101st Engineers, France

GEO. R. McLEOD
Claremont
103d Engineers,
Spartanburg, S. C.

JOSEPH PRENDERGAST
Claremont
(right) at Camp Devens,
Mass.

HARRY F. BLAKE
Claremont
101st Engineers,
France

SULLIVAN SERVICE FLAG

One hundred and eighteen former employes of the Sullivan Machinery Company are now in Uncle Sam's service in some military capacity. The accompanying photograph shows the Service Flag which hangs in the general offices of the Company at Chicago.

The following notes give news of Sullivan men in service and show that they are receiving their share of promotions and assignment to active duty:

D. P. O'Rourke, formerly attached to the Denver office of this Company, has enlisted in the Army Engineer Corps.

Herman M. Brown, San Francisco office, is ranking lieutenant, 21st Balloon Company Observation School at Fort Omaha, Nebraska. He writes that he has made more than eighty flights this year.

E. F. Burton, formerly attached to New York office, graduated from the Second Officers' Training Camp at Plattsburg, as Second Lieutenant Infantry, U. S. R., and is at Camp Dix, New Jersey.

Leslie A. Hoffman, who has been at Claremont for several months, taking the technical apprentice's course, has enlisted in Government service as assistant tester in the U. S. Bureau of Standards, Aeronautic Instrument Section.

Second Lieutenant Austin Y. Hoy, Royal British Artillery, writes early in January that he is in active service in France. The London office of the Sullivan Machinery Co. will be very glad to see any soldier, sailor or engineer readers of MINE AND QUARRY who may be coming through London on their way to the front. (Salisbury House, E. C.)

Harold S. Worcester, formerly attached to the Juneau office of this Company, attended the Second Officers' Training Camp at the Presidio, San Francisco, and has received his commission as Second Lieutenant in the Signal Officers' Reserve Corps.

Chas. B. Officer graduated at the Second Officers' Training Camp, Plattsburg, as a lieutenant. He has been assigned to the Coast Artillery Officers' Reserve Corps, and is in France.

Henry C. O'Brien, Boston office, has enlisted in the Aviation Corps and is attending the school for aviators at Massachusetts Institute of Technology, Cambridge, Massachusetts.

R. E. Benedict, Spokane office, has enlisted in the Twenty-seventh Engineers, the mining regiment, and has reported to Camp Meade, Maryland, for training.

Robert H. Officer (Claremont) is a Corporal, in the 1st Battalion, 30th U. S. Engineers, (Gas and Flame regiment) and is in France.

M. J. Pontius, (Chicago office) is at Great Lakes, Illinois, in the Quartermasters' School.

Chas. H. Coffin, Huntington office, who was obliged by illness to resign from the Second Officers' Training Camp at Ft. Benjamin Harrison, Ohio, last September, has been accepted for service in the Quartermaster Corps, U. S. Army, and is in training at Camp Johnston, Fla.

Sidney F. Greeley, formerly assistant advertising manager, Chicago, has been promoted from second lieutenant, 333d Heavy Field Artillery, Headquarters Co., to first lieutenant, dating from January 1. Lieutenant Greeley has been acting first lieutenant since the establishment of the cantonment at Camp Grant in September, and a portion of the time acting captain of the company. He has recently been detailed as one of the aeroplane observers for his regiment.

J. I. Edwards, formerly of the Mexico City office, is now attached to the Engineering Corps' General Supply Depot in Washington.

Chas. G. Miller, formerly attached to the St. Louis office of this Company, is now rock excavating expert, attached to Co. E of the 110th Engineer Regiment, Fort Sill, Oklahoma.

F. E. O'Neil, formerly in the Bookkeeping Department at the Chicago General Office, is with the Base Hospital, Camp Grant, Illinois.

M. R. Blish, formerly assistant to Mr. H. T. Walsh, sales manager at Chicago, and since May acting manager of the Denver Branch Office, is a captain in the Ordnance Department, U. S. A., on inspection duty, South Bethlehem, Pennsylvania.

Lieutenant R. A. Lowry, Huntington office, is now attached to the Twenty-eighth Engineer Regiment and has been drilling recruits at Camp Meade, Maryland. The twenty-eighth is the quarry regiment.

Major Geo. W. Blackinton, formerly manager of the Denver office of this Company, is in command of the Third Battalion, 353d U. S. Infantry, National Army, at Camp Funston.

L. L. Craig, H. F. Breault, Adelard F. Raymond and Arthur C. Parent have left the Claremont Works to enlist as mechanics in the Aviation Corps at Fort Slocum, New Hampshire. Leslie C. Cady is in the National Army.

The following is a list of the employes of the Chicago Works of the Sullivan Machinery Company who were selected by the draft, and who are now in the National Army at Camp Grant, Illinois, and elsewhere:

GEO. W. HASKINS,
U. S. Signal Service,
Aviation Section

Kanstenst Andryanskas
R. Brady
Claud Dillenback
Wm. H. Garland
John Ginowski
Jos. Gregorek
Edward Kieper
Victor S. Larson
Adam Muller
Chas. Roose
Joseph Sbiansky
Fred Boss
George Boss
Jim W. Coppersmith
John Pormos
James A. Rice

Walter F. O'Brien, Manager, Juneau office, has been commissioned as 1st Lieutenant, Trench Warfare section, Ordnance Dept., U. S. Army and is at Washington for instruction. He expects to qualify as an instructor in the art of bomb-dropping.

Drafted and enlisted from Claremont works, in addition to earlier lists:

Geo. R. McLeod, 103d Engineers, Spartanburg, S. C.
C. J. Harrington, Co. I, 311th Infantry, Camp Dix.
Wm. C. Baker, Ft. Williams, Me.
Everett McCleary, Company M, 103d Infantry.
Thomas Martin, now at Camp Devens.
J. W. Veasey, now in France.
Cleo Albee, United States Navy.
J. N. Sinnott, 60th Squadron Aviation Camp, Waco, Tex.

At Ft. Slocum Aviation Camp:

H. A. Armstrong, 4th Co., Signal Corps.
Harvey S. Knight.

R. S. Weiner, formerly of the El Paso office, is in the National Army, 340th Field Artillery, Battery E, at Camp Funston, Kansas, and is attending the Third Officers' Training Camp.

Geo. W. Haskins, Huntington office; Cadet, Flying Corps, Call Field, Wichita, Texas.

John A. Durward, Claremont, U. S. S. "May," last heard from at Gibraltar.

Roger Higgins, Claremont drafting room, U. S. S. "Montana."

C. G. Boudette, Claremont, Co. A, 101st Engineers, France.

Harry F. Blake, Claremont Premium Dept., Co. A, 101st Engineers, France.

Joseph Prendergast, Claremont Foundry, Co. A, 38th Engineers. Ft. Myers, Va.

John A. Thayer, Claremont Tool-Making Dept., 29th Company, Fort Leavitt, Me.

MINING IN CUBA is presented in attractive and comprehensive form by the bulletins of the Cuban Department of Mines, which are being issued at regular intervals. They contain scientific reports and economic data of much interest, and are freely illustrated and handsomely printed.

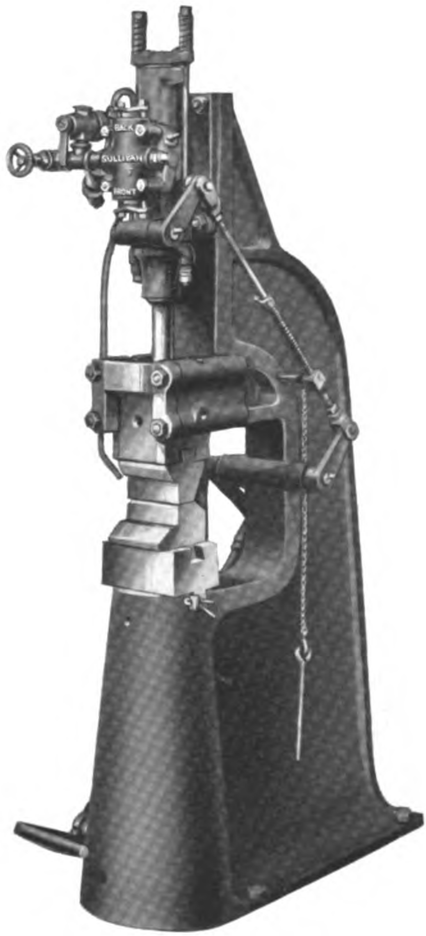
A NEW CUTTER-BIT FORGE HAMMER

This photograph illustrates the Sullivan cutter bit sharpener and general utility light forging hammer, operated by compressed air. As indicated, it was first designed for forging pick-point and chisel-point steel cutter bits, for use in Sullivan Ironclad chain coal mining machines. For this work it is recommended instead of the Sullivan standard drill sharpener, as no upsetting is required.

As many as 2000 chain machine pick-point or chisel-point bits per 10-hour day can be sharpened on one of these machines. This assumes the use of a gas or oil forge for heating the stock. Separate dies are required for making the two kinds of bits.

By substituting ordinary forging dies for the special cutter-bit dies, a great variety of light forging work may be done quickly and at low cost with this machine. This would include light welding and any blacksmithing work that would ordinarily be done with a hand sledge, on round or square stock up to two inches in diameter.

This new Sullivan hammer consists of a rigid cast iron frame which supports the guide block, and a vertical engine similar to that used on Sullivan drill sharpeners. Air is admitted to the engine through a pipe connected with the source of the air supply, and live air is kept in the lower end of the cylinder at all times by means of a pin sustained against the front end of the valve by a spiral spring, as is the case with the drill sharpener. When the foot lever is depressed by the blacksmith, the pin drops, the valve starts and the hammer begins to strike. The photograph shows the arrangement of the valve rod, spring and foot lever. A single blow may be struck by this hammer or many in succession, either light or heavy, as required, at the will of the operator. The piston rod is tapered at its lower end to receive the guide block, to which is keyed the upper of the two swaging dies. Substantial guides, carefully machined, are provided for the block and dies to run in.



Sullivan Cutter Bit Sharpener

The dimensions of the vertical forging hammer are as follows:

Length	4 feet
Width	2 feet 6 inches
Height	6 feet
Cylinder diameter	2⅝ inches
Size of air inlet	1 inch
Net weight	1600 pounds

COAL MINING IN SOUTH AFRICA

By C. C. Smith*

Coal was first mined in South Africa about 1885, when gold was discovered in the Transvaal. The first exhaustive report was made by F. W. North, an English mining engineer, for the Natal Government and was dated September, 1881. In 1889 a number of companies came into existence near Dundee, Natal.

In 1898 the strike of the Welsh miners gave the South African coal mines their first extensive export and steamship trade. Since that time that trade has gradually increased, as the coal, after being washed, makes a very good steam coal.

Coal is mined, to some extent, in each of the provinces of the Union of South Africa as well as in Rhodesia.

There are eighteen mines in the Transvaal, twenty-four in Natal, four in Cape Colony (these are of small commercial importance), one in the Orange Free State, and one in Rhodesia.

The principal coal fields, at present, are known as the Dundee field and the Middleburg or Witbank field. The Utrecht, Vryheid, and Ermelo fields were being developed rapidly before the war. The Springs district, which was so important to the Rand gold mines, has been practically worked out.

On account of the lack of steamship trade, due to the European war, the mines are not working near capacity. The total daily out put in 1914 was about 56,000 tons.

A level country, the Transvaal resembles Montana or Wyoming, but as slopes are very readily adapted to rope haul this type of opening is used where the cover does not exceed 150 feet.

The Natal coal field is in a more broken country and, except where the coal outcrops on the side of a hill, shafts are used. In the Natal field is the deepest coal shaft in South Africa—700 feet. There are also mines in Natal that are worked by drifts opened up 200 feet above the level of the railroad which runs in the valley.

Generally speaking, mining conditions in the South African coal fields are very favorable. In Natal some gas is encountered and there are a few mines that have a little water to contend with, but the Middleburg district in the Transvaal has mining conditions as nearly ideal as it is possible to conceive.

Most of the mines are working the bord-and-pillar system, but a few use the Welsh double-stall system.

Map of a part of South Africa, showing coal areas

A—Middelburg District
B—Vereeniging Field
C—Natal Field
D—Cape Coal Field

LABOR AND ORGANIZATION

The South African mining engineer is confronted with a labor proposition

*Claremont, New Hampshire.

unlike that of any other country. In no other place is the line drawn so closely as to what constitutes a "white man's work." If a new arrival oversteps this line, the nearest white man informs him of his error.

The white staff at a mine consists of the compound manager, mine manager, under manager, top boss, electricians and mechanics, miners and shot-firers and the office force.

A mine having an output of two thousand tons per day in South Africa will have about twenty white men, who are all first-class mining men. The rest of the employees are native South African negroes, or Kaffirs. These natives contract to work for a period of six or twelve months and receive from one to two shillings a day—24 to 48 cents. At the end of their contract period the Kaffir generally returns to his native home, as he has enough to live on, in style, for the next year. This means an untrained class of labor at all times. The mines overcome this as much as possible by having their contracts so arranged that they release and receive a certain number of "boys," as the natives are called regardless of age, each month. The government regulations regarding the treatment and care of native labor are very strict.

In Natal, prior to the formation of the Union of South Africa, and during the time Natal was a British colony, Hindus were bought from India under a five-year contract system, but this labor was never allowed in the Transvaal.

The Hindus received 10 to 40 shillings, or $2.50 to $10.00 a month, and comprised at least 50 per cent of the labor in the Natal coal mines, but have more recently been replaced by native negroes to a great extent, as the government has prohibited the importation of Indian labor.

While there are some conflicting opinions it is generally admitted that the Hindus are superior to the Kaffirs, especially for the positions not requiring great strength. They are not anywhere near the equal of the native for physical endurance or manual labor.

One can not say that the Kaffirs are thrifty or intelligent, but when one considers that they are, even today, but a few steps from the original wild, warlike tribes, it is remarkable what efficient workers they become; and without the native South African, mining could never have reached the high state of efficiency that is everywhere so noticeable in that country today.

AMERICAN COAL CUTTERS ADOPTED

The first coal-mining machines were installed in South Africa in 1906 when several companies started using American (Sullivan) Compressed Air Pick Machines. These proved very efficient and punchers installed at that time are still in use. An average day's work was four boards, or twenty feet of face, cut to a depth of five feet. This low rate of cutting was due to the unskilled labor; and when the post punchers were developed they replaced the board punchers rapidly. No attempt was made to "square the cut" with the post punchers, and two boys would cut two places twenty feet wide in one shift of ten hours. They used a ten-foot extension bar and the cut would average about seven feet in depth in the center.

As the mines advanced, the air line losses reached a high point. Some companies installed electrically driven haulage units, and, the natural conditions being favorable, chain machines were tried.

One of the companies installed an American made (Sullivan) continuous cutting chain machine, using a chain haulage and friction drive. This machine overcame the disadvantages that had been met before, as the friction could be set so that the machine could not be damaged by the ignorant laborers.

Since the first machine of this type was given a trial, the other mines have adopted them as rapidly as possible. The

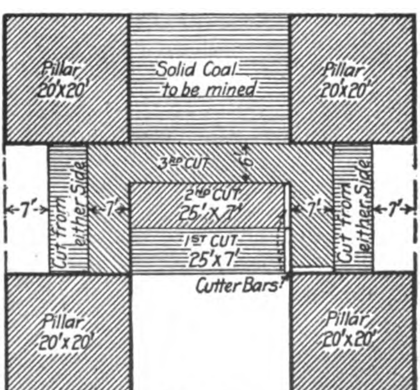
general practice is to install A. C. machines, as there are no haulage locomotives in use. While several mines in Natal have used Sullivan Chain Machines for the last eight years, in the Transvaal the colliers felt for some time that, without more intelligent labor, coal cutters of the continuous cutting type could not do better work than the Sullivan Pick Machines and the post punchers.

"IRONCLADS" MEET FAVOR

In 1914, however, one of the Transvaal mines installed a Sullivan Ironclad Coal Cutter with 7½-foot cutter bar. This machine, when handled by native Kaffir labor, averaged, for a period of two months, seven places 25 feet wide per shift, giving an average of 1267 square feet of undercutting per shift.

When it was demonstrated that the Ironclad type of coal cutter was simple enough for the inexperienced native boys to handle, the Transvaal collieries began equipping their mines with Sullivan Chain Machines and have made records that compare very favorably with the results obtained in other coal fields of the world with the latest improved type of Sullivan "CE-7" Undercutters.

The coal is undermined as shown by the attached sketch. While a 7½-foot cutter bar is used it was found more satisfactory to follow this system, and the miner in charge of the district makes a chalk mark on the ribs to show the machine men where to cut.



Plan of a South African Mine Room

After the first or second cut is made two rib shots and a center shot are fired by the shot-firer, after the day shift has left the mine. The natives drill the holes, but are not allowed to handle explosives at all.

The third cut gives a better grade of lump coal and requires less explosive per ton of coal. The section left in the cross cut also gives a very good porportion of lump coal and this mining is put in from the side.

No attempt has been made to pull pillars; but this pillar coal is not lost, as it can be mined later when more skilled labor is obtainable. The writer saw sections worked ten years ago that were standing perfectly.

After the coal has been undermined and shot, the place is inspected by a white miner and is then loaded out by the boys. The boys load the cars and push them to the nearest haulage way, where they get empties, and return to their places. This tramming distance will average about 200 feet and the boys will load six to ten tons a shift.

Where open lights are used the "full shift" carbide lamps are used generally, but some of the boys use candles. As the natives do not wear caps, cap lamps are not often used, although the writer has seen negroes with cap lamps hooked in their hair!

The general practice in the coal mines is to work ten-hour shifts.

A TYPICAL TRANSVAAL MINE

The following brief description of one of the Transvaal mines may seem too good to be true to mining men in some fields, but is only an average of the mines in this district.

The seam is level and has from 100 to 200 feet of cover. The average thickness of the seam is 12 feet. The top two feet of this makes an ideal roof.

The mine was opened by a slope and is worked on the bord-and-pillar system with 20 to 25 feet working places and pillars 20 feet square.

The coal is undercut with Sullivan Ironclad Coal Cutters to a depth of 7½ feet and is shot in two sections, the lower 5½ feet being taken first. The remaining top coal is taken as needed.

No fan is needed to ventilate this mine, (although, at the time of the writer's visit, the average daily output was 2000 tons), as the overlying strata are alluvial gravel and clay, and with the cheap labor available an air shaft could be sunk for a few dollars. In fact, while there are one or two mines in the Transvaal that have fans, the majority of them depend upon a number of air shafts for ventilation.

The power for the Sullivan coal cutters and the motors used to drive the haulage is furnished from a central power station at 2200 volts and stepped down to 220 volts.

The smooth bottom left by the Ironclad machine provides a perfect floor for the track, which is made of 16-pound steel with steel ties, no grading being necessary at all.

The only timber underground is that used for the frames of the rope-haulage sheaves, and while there is enough water to keep the mine from being dusty, only one small pump is used, furnishing water for the power plant, and the sprinkling system used before shooting.

WORKING FORCE

The underground staff at this mine consisted of one mine foreman and eight assistants or section foremen, who are all white men. Each section foreman has from 40 to 60 natives.

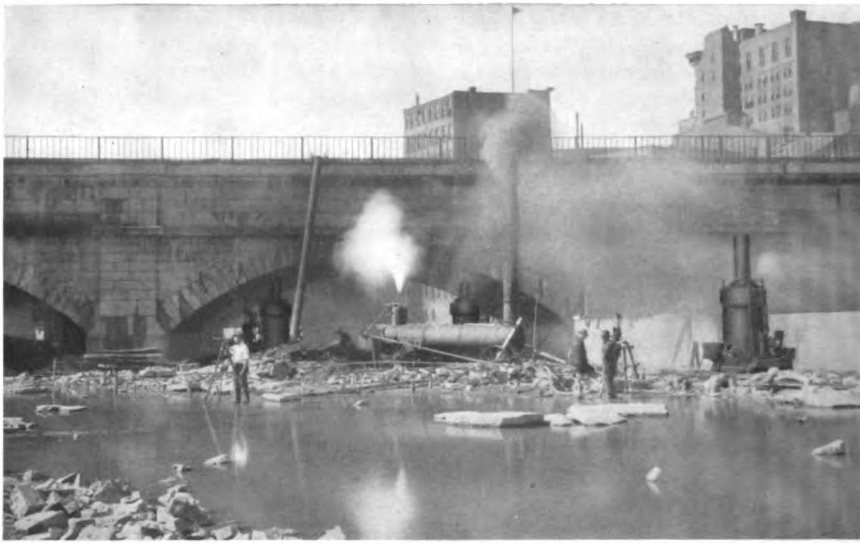
The compound, or quarters of the negroes, is of special interest. It is in charge of a man licensed by the government to be a compound manager and consists of a quadrangle containing rooms for the natives, with the kitchen in the center.

The compound managers must be able to speak the various native languages, of which there are several, as each nation or tribe has a different language, but the underground men need only to be able to speak Kaffir, which is understood by practically all the boys received by the mining companies.

Overhead continuous rope haulage is used exclusively in the coal mines of South Africa. The pit-cars or tubs hold about 700 pounds and are trammed by hand from the face to the nearest rope. Except where the water is strongly acid, steel ties are used. "Gooseneck jockeys" are in general use except where the grades are prohibitive.

ANGLE COMPOUND COMPRESSORS EASILY MOVED

The accompanying photograph shows a Sullivan Class "WJ-3" Belt-driven Angle Compound Compressor, loaded on an automobile truck, starting for the quarry of the Northwest Magnesite Company, near Chewelah, Washington. Owing to the compact design of the Angle Compound machine, whose low-pressure cylinder is horizontal, and whose high-pressure cylinder is vertical, it is possible to handle it for transportation over rough country and on mountain roads, with a minimum of inconvenience.



Deepening the Genessee River at Rochester, New York. A Sullivan Channeler is at work adjoining the concrete partition wall at the right, and three more are under the bridge arches

CHANNELERS AID ROCHESTER FLOOD IMPROVEMENTS

BY C. G. CUMMINGS*

The accompanying photographs, recently received, illustrate unusually well one of the typical and most valuable applications of stone channeling machines; viz., their use for cutting rock walls as a substitute for drilling and blasting, when proximity to existing structures renders the usual practice dangerous. Walls cut in this way are solid and unshattered, frequently standing for long periods without lining or repair; they are smooth, offering minimum frictional resistance to the flow of water; and they require no trimming or filling to bring them true to the surveyor's lines.

The city of Rochester, New York, let a contract, early in 1915, to the Shongo Construction Company, of Rochester, for deepening the bed of the Genessee River between the brink of the falls and a point just south of the Court Street bridge, a distance of about 2000 feet. The river is about 300 feet in width, and the average cut to be made was six feet, amounting to about 500,000 cubic yards, practically all in rock.

The object of the improvement is to eliminate the flood menace. Floods have cost Rochester thousands of dollars in past years. The river rises quickly after rains, and this factor rendered the task a hazardous and sometimes a costly one, from the contractor's standpoint.

A substantial concrete wall was first built down the middle of the section to be deepened, and the river was diverted first to one side and then, when the work there was completed, to the other.

The river is lined on both banks by large buildings. In addition there are five bridges and an aqueduct supported on piers crossing the river. In order to eliminate the danger to the building and bridge foundations that would have attended blasting, channeling was decided on, and channel cuts to a depth

* 1404 South Geddes Street, Syracuse, New York.

of six feet were made along each bank of the river, and around almost all the bridge piers. At some piers line drilling was permitted. A channel cut was also put in along the east side of the concrete wall. The total amount of channeling required was about 50,000 square feet. The rock is hard limestone with an abundance of seams.

For this feature of their contract the Shongo Construction Company selected Sullivan Stone Channelers, on account of the excellent record in cutting speed and repair economy made by these machines on the New York State Barge Canal. There are five channelers in all, two "Y-8" eight-inch, two "Z" seven-inch, and one class "Y" with seven-inch chopping engine cylinder. These machines are all steam-operated, carrying their own boilers. One of the pictures shows the elbow in the smokestack, used when working under the bridges on account of the low head-room and the resulting annoyance from smoke.

The contractors completed the east side of the improvement at the close of last season, and expect to finish the remainder of the job this year. Work is stopped during the winter on account of weather and labor conditions.

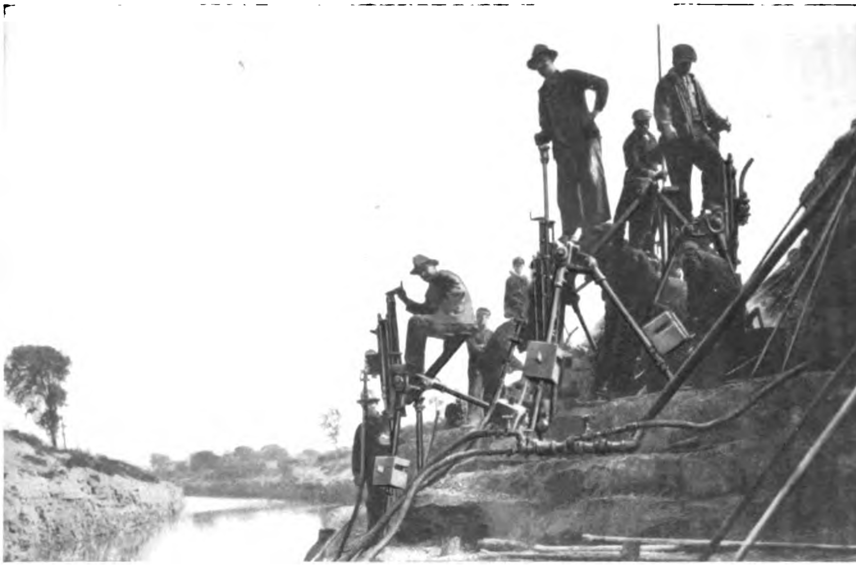
WOOLSEY CONSTRUCTION COMPANY

On contract No. 21A of the barge canal, near Rochester, the Woolsey Contruction Company has been using a Sullivan Class "Y" seven-inch channeler for making cuts under the highway and railroad bridges. Most of the channeling on this section was finished before the present contractors began work. The cut is very deep, about 30 feet, and the walls were channeled in eight-foot lifts. Sullivan "DP-33" 38-pound Air Tube Rotators are also employed for line drilling on this contract, and have been drilling to a depth of 12 feet at some points. Nine of them are in use.

NEW YORK STATE DREDGING CORPORATION

Contract No. 21A, mentioned above, is connected on the west with the next regular section of the barge canal by a contract which included a considerable

Sullivan Channeler cutting under a viaduct, Rochester, New York



Sullivan Hyspeed Rock Drills excavating for bridge foundations on the New York State Barge Canal near Rochester, New York

amount of rock removal, and the installation of the new four-track bridge for the New York Central Railroad.

The photograph on this page shows in silhouette a group of Sullivan 3⅝-inch Hyspeed Steam Rock Drills, of which six were used by the contractor for drilling the 22-foot vertical holes required on this part of the work, near the bridge. These drills averaged 50 to 60 feet per shift. The holes were started at 3¾-inch diameter, and were bottomed for 1½-inch powder. They were spaced only four feet apart and shot with relatively light charges, to avoid damage to the bridge foundations. The "man on the job" reported that the rock was broken and full of mud seams, tending to catch and hang up the drill steel; also that the Hyspeed drills, which are heavily built for severe service and equipped with an auxiliary valve action, stood the constant strain perfectly.

A Sullivan Drill Sharpener made bits for this job as large as 3⅝ inches, on 1½-inch steel.

On contract No. 18-A, near Little Falls, N. Y., the New York State Dredging Company also used 10 Sullivan "FG-3" 2¾-in. Hyspeed Steam Drills for lighter work, and several "FV14", 5-in., submarine Sullivan Drills for subaqueous work.

HAMMER DRILLS CUT PAVEMENT AND DRIVE SHEETING

By R. P. McGrath*

The accompanying snapshots, taken on Market Street in San Francisco, show work which the Pacific Gas and Electric Company did last fall with Sullivan 40-pound Hammer Drills. Market Street is paved with a heavy concrete base with an asphaltum capping. In most places there is about six inches of asphalt. The Pacific Gas and Electric Company have occasion to take up the street in

* Hobart Building, San Francisco.

different places to get at their pipes and wires. Cutting through this asphalt and concrete is very slow and expensive work, so they are using a small electrically driven compressor on wheels to operate Sullivan "DC-19" Drills, using square-pointed gads from nine inches to two feet long.

In blocking out the work, they cut a trench around the asphalt which is to be removed with a chisel-shaped tool having a cutting edge about three inches long; and the other end of the steel is made into a shank like that used on standard drill steel, and fits into the chuck of the "DC-19" drill.

In most cases, where the concrete under the asphalt is very hard, they have used the Sullivan Class "DP-33" Rotator Drill with regular ⅞-inch steel, and drill holes at an angle of about 45°, into which wedges are driven. Usually, however, after an opening has been made in the concrete, the remainder can be removed around the sides of the opening by gads driven by a "DC-19" tool.

Most of the gads used in the "DC-19" drills have a ¼-inch hole bored through them near the shank and this hole permits

Fig. 1. Sullivan "DC-19" Drill and Chisel Bit, used in cutting pavement

the gad to be attached to the tool by means of a chain. The upper end of the chain is attached to a clamp which is fastened around the head of the tool, as illustrated in Figure 1.

"DC-19" tools are also used for driving lagging, as illustrated in Figure 2. After the hard surface of the street has been removed it is necessary to drivelagging into the soft sand. The "DC-19" has proved very satisfactory in driving 2 x 4 and 2 x 6-inch planks. An idea of its effectiveness for this work can be gained from the fact that at 100 pounds air pressure, this 45 pound tool strikes 1750 blows per minute, each equal to a 27 pound weight falling from a height of one foot, or a total of 47,250 foot pounds per minute.

Fig. 2. Driving planks for lagging with Sullivan 40-pound Hammer Drill

AIR LIFT SUPPLIES WATER AT MILK PRODUCTS PLANTS

By C. G. Cummings* and John Oliphant†

The question of water supply is an important one for many readers of Mine and Quarry. This article cannot fail to prove interesting to any who draw their supply from wells.

The Merrell-Soule Company, Syracuse, New York, manufactures milk powder and has plants at Little Valley, New York, Warsaw, NewYork, and Omaha, Nebraska. The question of water supply is an important one, as large quantities of water are necessary for condensing. At these three plants the supply is taken entirely from deep wells in order to have pure water. In 1915 it was found that the Little Valley plant was not getting sufficient water; and, after investigating various systems, it was decided, on representations of engineers of the Sullivan Machinery Company of New York City and Chicago, to install an improved air lift system to replace the mechanical pumps then in use. The results of this replacement were so satisfactory that during the past year the company has installed Sullivan Air Lift equipment at Warsaw, New York, and at Omaha, Nebraska. The advantages of the air lift, aside from increasing the volume of the water supply, consist in delivering the water at a lower temperature than is possible with mechanical pumps; second, the water is purer, as the action of the air tends to soften it, rendering danger from boiler scale less objectionable; and chemicals which may be held in solution are frequently liberated by the air, or their effects nullified. Third, there are no moving parts in the well to get out of order; and, fourth, the quantity of water required is always under the control of the engineer in the air compressor room, and can be increased or diminished by varying the speed of the compressor.

Inasmuch as each of the three plants represented different conditions to be met by the air lift system, it is believed that not only milk producers, but other manufacturers, and, in fact, any that use water supply from wells will be interested in a brief description of the methods employed and the equipment installed.

LITTLE VALLEY, NEW YORK, PLANT

In 1915 there were five wells at the Little Valley plant of the Merrell-Soule Company, averaging about 60 feet in depth. These were pumped with deep well pumps of various makes and sizes, and one well was equipped with a large triplex pump, placed in a concrete pit several feet below the surface of the ground to secure proper suction. This pit formerly contained two 6-inch wells. One of these has now been enlarged from a 6 to an 8-inch well, and is known as No. 3. The other 6-inch well is now used as an overflow.

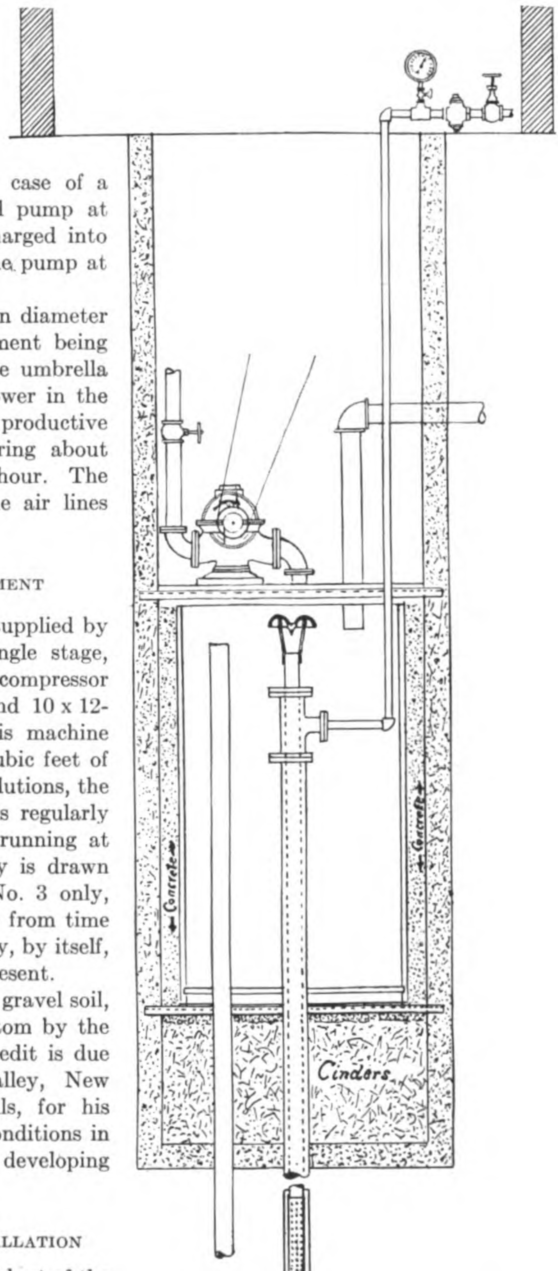
After the decision had been reached to equip the wells with the air lift system, three of the wells were deepened to about 80 feet. A test well 6 inches in diameter was first drilled. After making a test it was decided that 120 gallons per minute could be pumped with best efficiency. After the pump was installed, however, 126 gallons per minute were actually produced. This well, known as No. 6, is equipped with one Sullivan special pump, three inches in diameter. The discharge or reduction line consists of 3-inch standard pipe and is equipped with an umbrella well top or separator. The water from this well discharges into a concrete pit. Water from this pit is discharged through a 4-inch pipe by gravity to well No. 4.

Well No. 4, 8 inches in diameter and 80 feet deep, is fitted with a 4½-inch Sullivan special pump with umbrella well

*Syracuse, New York. †Peoples Gas Building, Chicago

top, and the water, after discharging into a concrete pit, is elevated to the service tank by a belt-driven centrifugal pump. No. 4 well pit is also connected with the pit at No. 3 well, so that in case of a break-down of the centrifugal pump at No. 4, the water can be discharged into pit No. 3 and elevated by the pump at that station.

Well No. 3 is also 8 inches in diameter and 80 feet deep, the equipment being similar to that at No. 4. The umbrella separator or well top is set lower in the pit, however. This is the most productive well on the property, delivering about 18,000 gallons of water per hour. The figure on this page shows the air lines to the various wells.



Well No. 3, Little Valley, N. Y.

AIR COMPRESSOR EQUIPMENT

Air for these three wells is supplied by a Sullivan Type "WA-3" single stage, straight line steam driven compressor with 9-inch steam cylinder and 10 x 12-inch air cylinders. While this machine has a rated capacity of 174 cubic feet of free air per minute at 160 revolutions, the necessary quantity of water is regularly secured with the compressor running at half speed. The water supply is drawn part of the time from well No. 3 only, alternating with wells 4 and 6 from time to time. Well No. 3 can supply, by itself, all the water needed for the present.

These wells are all drilled in gravel soil, and were enlarged at the bottom by the use of a blow pipe. Much credit is due William Bushnell, Little Valley, New York, who drilled these wells, for his thorough knowledge of well conditions in this section, and his skill in developing the wells at Little Valley.

WARSAW, NEW YORK, INSTALLATION

At the Warsaw, New York, plant of the Merrell-Soule Company water is taken

from a single well, 175 feet deep and 5⅝ inches in diameter. The Sullivan air lift plant was installed in the fall of 1917. This consists of a Sullivan straight line 9 x 10 x 12 "WA-3" steam driven air compressor, similar to that at Little Valley; the pump is of the Sullivan central type, in which the air line passes down through the center of the discharge pipe to the pump. The air line is enlarged, being 3¼ inches in diameter part of the way and 3½ inches in diameter for the remainder. Inserted joint casing is used to secure a free flow of water and minimum friction for the combined air and water discharge. The large air line is used to reduce the discharge or output of the well to the capacity desired. Water is discharged into a Sullivan Cast Iron Booster, 30 inches in diameter by 30 inches high. In this the water is separated from the air and carried in a separate pipe to the compound jet at the base of the riser line. (See above.) The air from the well is thus utilized a second time to lighten the column of water in the vertical discharge above the surface of the well and at the same time eliminate the retarding effect which would take place if the air were carried with the water through the horizontal line.

The capacity of this well is at present 200 gallons per minute, or 12,000 gallons per hour.

OMAHA, NEBRASKA, BRANCH

The Merrell-Soule installation at Omaha, Nebraska, includes the following air lift equipment:

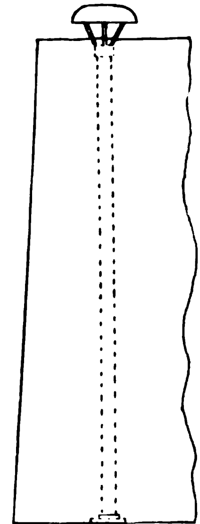
1 Sullivan 9 x 10 x 12 straight line, steam driven air compressor, Class "WA-3," with one 30-inch by six-foot vertical air receiver.

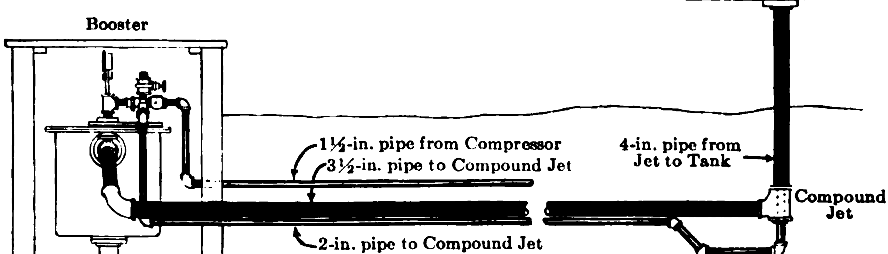
1 Sullivan Air Lift Booster, 36 inches in diameter.

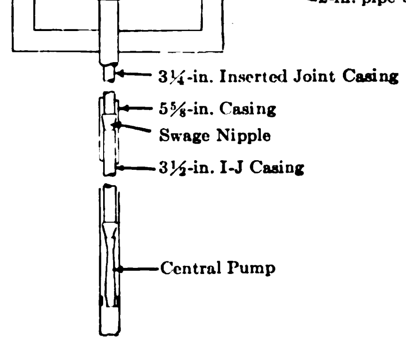
1 5-inch by 1½-inch Standard foot piece, for pump, with outside air line.

1 10-inch well top or umbrella separator.

The layout of the well is shown on page 1039. The air compressor, receiver and water tanks are located in the engine room of the plant, but the well itself is situated in another plant across the street, and the water is delivered by means of a long, horizontal run of pipe 5 inches in diameter, from which it is then elevated to the





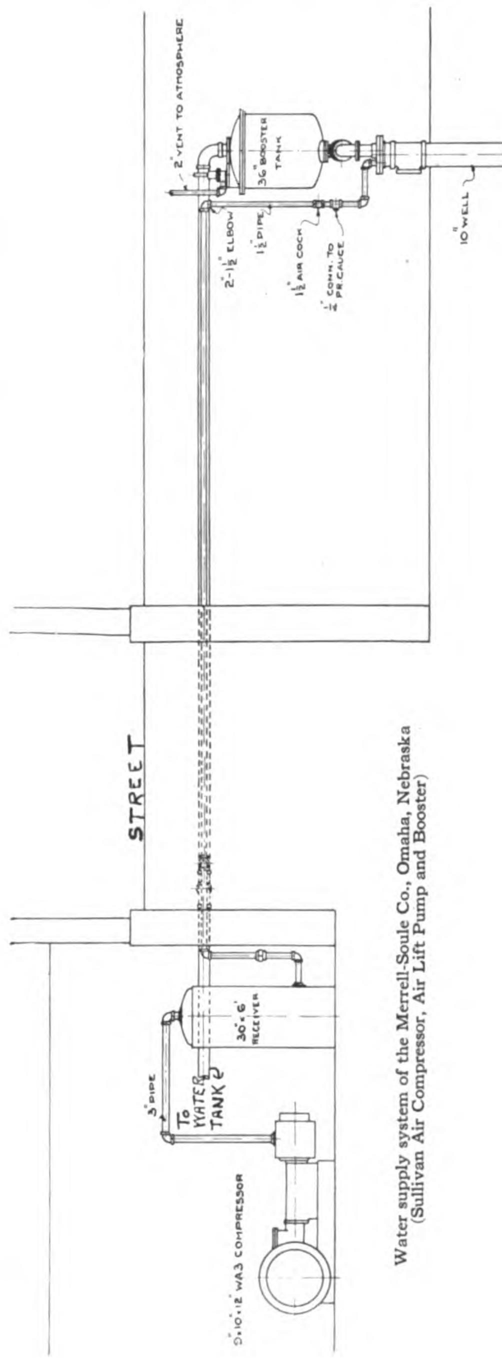


service tank by the booster pressure. The air from the booster is allowed to escape into the atmosphere through the vent valve at the booster.

The well presents considerably different conditions from those described in the New York state installations: It is 2200 feet in depth with a diameter of 10 inches. The static level, when not pumped, is only four feet below the surface of the ground. When pumping, the drop is 30 feet. The elevation, including a factor for friction of the horizontal line, is 24 feet above the top of the ground, making a total lift of 58 feet. The submergence is 100 feet, or 63 per cent, and the pump is placed at a depth of 134 feet in the well. The operating pressure on the water is 58 pounds, and, under these conditions, an output of 400 gallons per minute, or 24,000 gallons per hour, is secured. For the present, however, 17,000 gallons per hour is sufficient, and the Sullivan compressor is held in reserve, an air pump with 6 x 8 cylinder being used to supply the smaller quantity needed.

The adaptability of the air lift system to varying conditions of wells, volume required, height of pumping above ground level, and length of horizontal discharge, is very nicely illustrated by these three cases. The authors of this article are greatly indebted to Mr. O. Edward Merrell and Mr. J. S. Barnes for their co-operation in making tests, furnishing information and blue prints.

Iron Ore Occurrences in Canada.—Bulletin of the Canada Department of Mines, in two volumes, compiled by E. Lindeman, M.E., and L. L. Bolton, M.A., B.Sc., with introduction by A. H. A. Robinson, B.A.Sc. These two volumes consist of descriptions of the principal iron ore mines in Canada, and of a series of more than twenty charts and maps, which illustrate the descriptive matter in a very complete and even elaborate fashion.



Water supply system of the Merrell-Soule Co., Omaha, Nebraska
(Sullivan Air Compressor, Air Lift Pump and Booster)

DRILL BITS AND DRILL STEEL. II

By George H. Gilman*

Continued from Mine and Quarry for August, 1917, page 998. Copies of the first chapter will be furnished upon request.—Editor.]

The various letters and communications that have been received by me from mining men in different parts of the country, relative to an earlier article of the same title indicate that there exists in the minds of some readers a misconception of the facts that I attempted to set forth especially with respect to the essential qualifications of the rock-drill bit; and on the strength of requests for more detailed information on several phases of the subject that were generalized upon in the article referred to, kindly permit me to elaborate on several points that apparently were not made sufficiently clear.

The essential qualifications of the rock-drill bit, regardless of the conditions under which it is used, are as follows:

DISTRIBUTION OF WORK THROUGHOUT THE ENTIRE LENGTH OF THE CUTTING EDGE

It is desirable to have the bit so made that the load is evenly distributed throughout the entire length of the cutting edge. In other words, the shape of the cutting edge and the manner in which it is applied to the work should be such that when dulled by natural wear, the flattened surface will be approximately uniform throughout the entire length of the cutting edge. As an illustration, if we were to so proportion a single-cutting-edge chisel or bull bit as to have it meet this requirement, it would assume a scroll shape corresponding to the letter S (as shown by Fig. 1A) with the length of the cutting edge per unit of distance from the axis of the bit increasing with the square of the diameter. Such a bit is obviously impractical, but by making a bit with four wings instead of two, it is practical to secure the desired result (with a shape as shown by Fig. 3A) without increasing the total length of the cutting edge but slightly more than that of a drill bit having a length of cutting edge double the diameter of the drill hole, which has been found to be desirable for average conditions of ground.

Fig. 1A.
Method of developing a single cutting edge bit of such shape that the work is evenly distributed throughout the entire length of the cutting edge.

It should be so made that the cutting edge may be tempered uniformly throughout its entire length by a practical method. This may be accomplished by equalizing the area of conductivity throughout the entire length of the cutting edge, to insure a uniform distribution of the heat from the massive portion of the bit rearward of the cutting edge, for drawing the temper. In the previous article the double-arc bit (Fig. 12) and the chisel bull bit (Fig. 5) illustrate typical examples of drill bits possessing this qualification. The cross-bit (Fig. 8) is of the type which provides for a very uneven distribution of heat from the massive portion to the cutting edge.

The bit should be so formed that the depressions made by the cutting edge as it is rotated axially in the drill hole cross each other at a slight angle, thus causing the rock to be broken in diamond-shape chunks from the bottom of the drill hole, instead of chipping or crushing it radially, which is the result secured with the cross, chisel, rose and other types of radial-cutting-edge bits. The methods of fracturing the rock with the double-chisel bit (Fig. 10), the "H" bit (Fig. 11), the double-cross bit (Fig. 9) and the

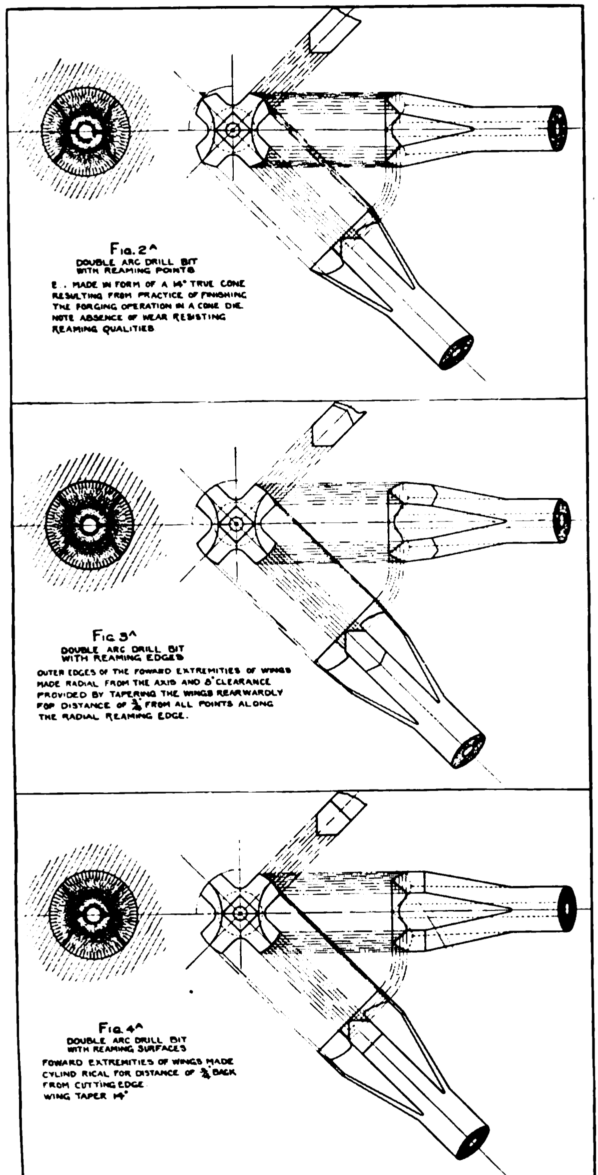
*Chief Engineer, Pneumatic Drill and Channeler Department, Sullivan Machinery Co., Claremont, N.H.

double-arc bit (Fig. 12), as shown by the diagrammatic drawings, indicate the manner by which this may be accomplished.

METHOD OF SEVERING ROCK PARTICLES FROM MASS

The extremities of the wings of the bit adjacent the terminals of the cutting edge should be formed with either a reaming edge or a reaming surface. Under no circumstances is a reaming point desirable.

A reaming point is secured when a rock-drill bit is made in the form of a true cone, resulting from the practice of finishing the forging operation in a cone die of the drill sharpener (see Fig. 2A). A reaming edge is secured when the outer edge of the forward extremities of the wings are made radial from the axis of the bit and clearance is provided by tapering the wings rearwardly at a fixed angle from all points along the radial reaming edge (see Fig. 3A). A reaming surface is secured when the outer edges of the forward extremities of the wings are made radial from the axis for a fixed distance rearward of the cutting edge (see Fig. 4A).



Development of the double arc bit

A reaming surface may be employed to advantage only when the rock conditions are such that the natural transverse whipping action of the drill bit when struck by the hammer will cause it to cut a clearance for itself. The effect of this action is emphasized in ground of a granular nature in which the rock particles

are readily disintegrated from the side walls by the natural crushing or chattering action of the bit, under which conditions it will cut a round hole of greater diameter than the maximum diameter of the bit. Inasmuch as such reaming qualities, dependent upon the area of the surface in contact, provide for wear-resisting qualities, it is advisable to employ as great a reaming surface as the conditions of the ground will permit without imposing undue duty upon the rotating mechanism of the drill.

For all conditions of ground where a reaming surface is not permissible, it is recommended that the reaming qualities of the bit be determined by a reaming edge the clearance angle of which should be as slight as the conditions of the rock will stand. A clearance angle for the reaming edge of 5° should be employed in preference to an angle of 7° unless the greater clearance is essential to secure the required freedom of rotation, for the smaller the amount of reaming clearance the less will be the reduction in gage diameter by wear of the bit in service.

For average conditions of ground a cutting-edge angle of 90° is recommended. For soft ground a more acute angle than 90° may be employed to advantage, depending somewhat on the abrasive qualities of the rock, while for hard, brittle ground a greater angle than 90° may be employed. In ground of a flinty nature, which shatters readily, a cutting angle of 120° is permissible.

The width or thickness of the wings should be great enough to withstand without undue breakage the hardness of the ground to be drilled. The thicker the wings the less will be the available clearance for the ejection of the rock cuttings, but as the thickness of the wings may be increased in proportion to the hardness of the ground, the clearance space for the ejectment of the rock cuttings will decrease inversely in direct proportion, so that the requirements of the ground are automatically met by making a change in either direction. The degree of taper for the wings in blending the bit into the steel body should be such that the reaming and cutting edges are properly supported. For average conditions a wing taper of 14° gives the desired results.

BEST TYPES OF EQUIPMENT

When determining the best type of rock-drilling equipment for any fixed set of conditions, it should be remembered:

That the rock-drill bit is the business end of nearly every rock-excavating proposition.

That the logical way to drill holes in rock is by first determining the requirements of the ground and then providing drilling equipment to meet the requirements to the very best advantage. That this may be done only after you have decided upon the depth and the size of drill hole at its bottom diameter that will be required to handle the burden you are to impose upon it.

That when this is determined, the less the variation in size between the bottoming diameter of the drill hole and its mouth, the greater will be the rate of penetration throughout the entire length of the drill hole.

That the duty of a rock-drill bit is to disintegrate the rock particles from the bottom of the drill hole and also from the side walls.

That there is a wide distinction to be drawn between drilling a round hole in rock and in removing a corresponding amount of rock particles from the mass, under conditions where the rock may be disintegrated by chipping to a free face.

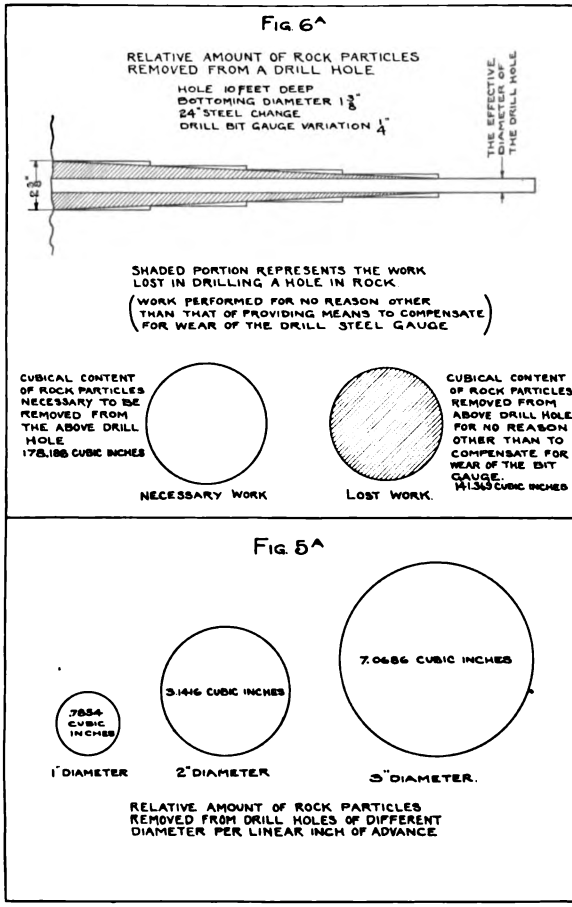
That by increasing the size of the drill hole from 1-inch to 2-inch diameter, the work that the rock-drill bit has to do is increased four times, and that when drilling a 3-inch diameter hole the drill bit has a duty to perform nine times as great as when drilling a hole 1 inch in diameter (see Fig. 5A).

That drilling speed in rock varies approximately with the square of the diameter of the drill hole; or in other words, the rate of penetration varies inversely with the amount of rock removed from the drill hole.

That the difference in area of the drill hole between its bottom diameter and its mouth represents work performed for no other reason than that of compensating for wear of the gauge of the drill steel (see Fig. 6A).

That it is possible to so make the reaming qualities of a rock-drill bit that wear will be slight and that under present-day conditions, if a ¼-inch variation in gauge is employed it is practical to reduce this to $\frac{1}{32}$-inch variation.

That under average present-day conditions rock drills weighing 150 pounds are employed for no other reason than that of securing a force of blow sufficient to cut rock with the large gauge bits that are used as starters, and that the use of drill steel of 1¼-inch diameter is required only to support the cutting end of large gauge bits.



Graphic analysis of the rock drilling problem

That with the hammer drill the absorption of energy of the blow in transmission to the rock increases with the weight of the rock-drill steel.

That vibratory shock is an important factor in the many causes that result in fatigue of rock-drill steel and that within reasonable limits a light, rapid blow produces more fatigue than a slower heavier blow.

That a heavy, slow blow does not wear the gauge of rock-drill bits in service as rapidly as a light, fast blow.

That you put life into rock-drill bits by hammering during the forging operation, which has the effect of refining the grain and removing forging strains that would otherwise exist. That when tempering drill steel, the one important essential is to quench the heated bits at the critical point.

That automatic quenching and tempering of drill steel is desirable.

That bits should be equipped with a reaming edge or a reaming surface—*never* with a reaming point.

That the cutting edge of a rock-drill bit should be so made that the work is approximately evenly distributed throughout its entire length. It is impossible to secure this result with a radial cutting-edge bit.

That the reaming qualities, the angle of the cutting edge and the thickness of the wings are the only variables required to adapt a bit to all kinds of ground.

DULL STEEL INDUCES BREAKAGE

That dulled drill bits are conducive to breakage of drill steel and drill parts, as breakage is largely determined by a lack of cushioning effect due to penetration.

That inspection of the finished steel before it leaves the smithshop and that such inspection of the bit and shank ends be made with ring limit gauges is recommended.

That under average present-day conditions an additional expenditure of $10.00 in the drill-sharpening shop should mean a saving of $200 underground.

That the one important point to strive for is to minimize the personal equation in the smithshop and also as applied to the operation of the drill underground.

That proper care in the selection and working of rock-drill steel will under present standard practice result in the use of lighter rock drills and mountings, dispensing with the "two-man" rock drill except under special conditions; in lighter and smaller air hose; lower air consumption, smaller drill steel, higher rate of penetration, less wear of drill bits per unit of depth of drill hole, better cleaning of drill holes due to reduction in size of drill hole, less drill steel, less breakage of drill steel, fewer stuck drill steels and less ill temper on the part of the drill operator.

(To be continued)

AIR LIFT FOR COMPRESSOR JACKET WATER

The accompanying illustration shows how the air lift system of pumping can be utilized to form a simple and effective method of supplying cooling water to air compressor cylinder jackets. A small tank is placed about eight feet above the compressor, which gives sufficient height to permit the water to flow by gravity through the jackets. Instead of using a pump for this purpose or for elevating the water to the gravity tank again, a needle valve, or, still better, an air-lift mixing tube controlled by means of a pin valve, is placed at the base of the riser, just outside of the water jacket discharge. This valve is connected by a small pipe with the air receiver and a small amount of air is thus forced into the riser pipe, acting to carry the water from the cylinder jacket back to the elevated tank.

The amount of water required depends, of course, on the size of the compressor. A 10 x 10 single stage machine, having a capacity of 213 cubic feet per minute, would require about five gallons per minute, and for this a one-inch pipe would be sufficient.

This plan of automatic cooling water circulation was worked out by Mr. Geo. H. Richey, one of the engineers of the Sullivan Machinery Company at Boston, who has installed it at several Sullivan Air Compressor installations in New England, as a substitute for a small centrifugal pump driven by an electric motor. Excellent results are secured and the heat in the water is reduced to a considerable extent by the expansion of air in the riser or eduction pipe. The sketch shows the system as installed for

a two-stage angle compound compressor. It is of course even simpler with a single-stage machine. In the installations referred to above, no trouble has arisen whatever, and the system has kept the compressors properly cooled.

ROTATOR MOUNTING FOR DRILLING COAL

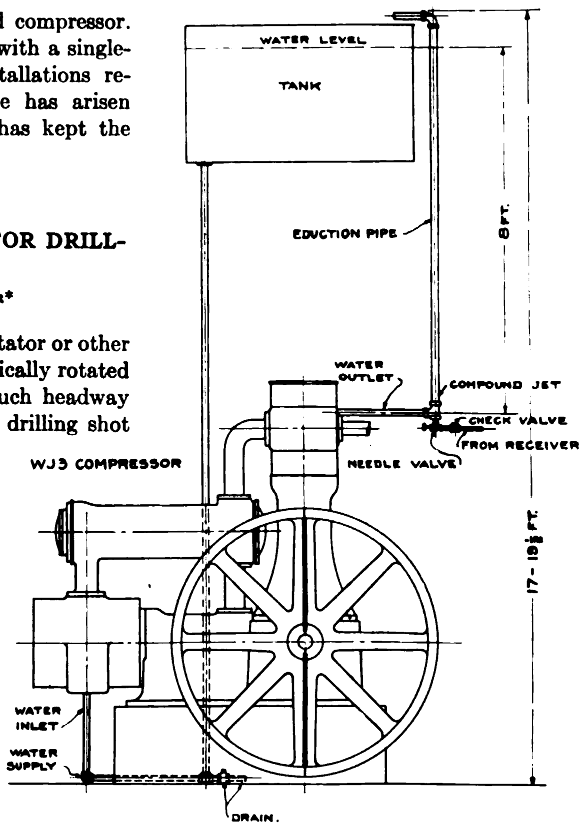
By B. B. Brewster*

The use of the Sullivan Rotator or other types of hand-feed, automatically rotated hammer drills has made much headway in the past year or two, for drilling shot holes in the coal face, when blasting is required after undercutting.

As a substitute for hand drilling, the Rotator, driven by compressed air and weighing only 38 pounds, is many times faster and is perfectly convenient to handle. This is its great advantage, also, over the hand or electric auger drills, which require a frame or mounting which must be braced firmly against the roof and floor, and reset for each hole drilled.

While the Rotator, in coal drilling, is readily operated by one man, even on deep holes, a drilling gang frequently comprises two men, simply to provide for greater speed in handling the drill, steel, hose, etc., and in carrying them from room to room. In coal of ordinary height (six feet or less), and for holes of ordinary depth, the operator, either alone or with a helper, has no trouble in supporting the Rotator by hand. For deep holes or high coal, in which the holes must be placed several feet from the floor, some form of simple mounting has been found desirable.

The accompanying sketch shows such



Air Lift for Jacket Water

a mounting, devised by the writer for this purpose, and used with success in at least two Utah coal mines. This consists of two rear legs or feet, joined at the top by a cross bar, having a tee in the center, in which is secured a horizontal bar or leg. The rear legs have a telescoping feature formed by drilling holes at regular intervals in the pipes, of two diameters, composing the leg; and a pin is inserted to hold the leg at the height desired. This mounting is made of ordinary pipe, one inch or one and a quarter in diameter, and fittings. It is set at the height desired, and the Rotator drill is hung under the horizontal bar or leg on two hooks, one on the drill handle, the

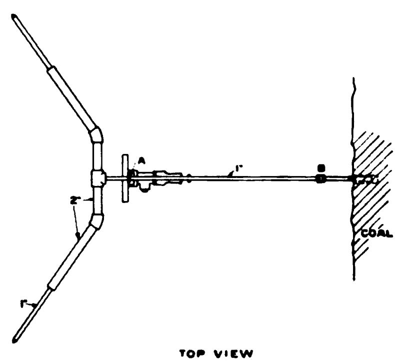
*Walker Bank Building, Salt Lake City.

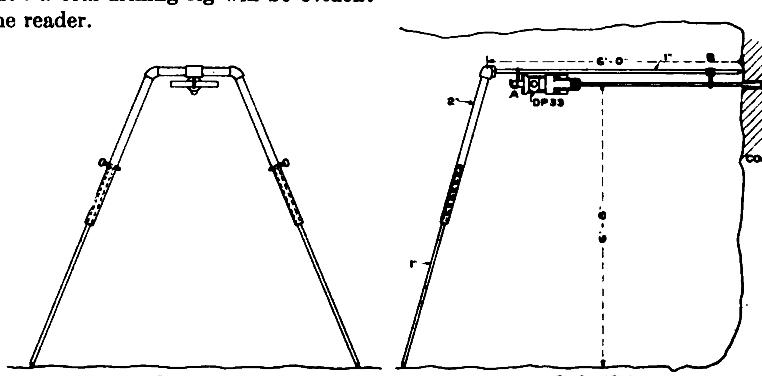
other at the bit end of the steel. This makes it unnecessary to hold the steel while collaring the hole. The operator merely steadies the drill and thrusts it forward to its work.

In the setting shown, holes were put in about 6½ feet above the floor, in 8-foot coal, and the drilling was done rapidly and easily. In this mine, where the coal was fairly hard, miners with hand augers drilled about 10 holes per man per shift; holes being 5 to 5½ feet deep. It required two, four or even sometimes six hours to drill the holes for a single room.

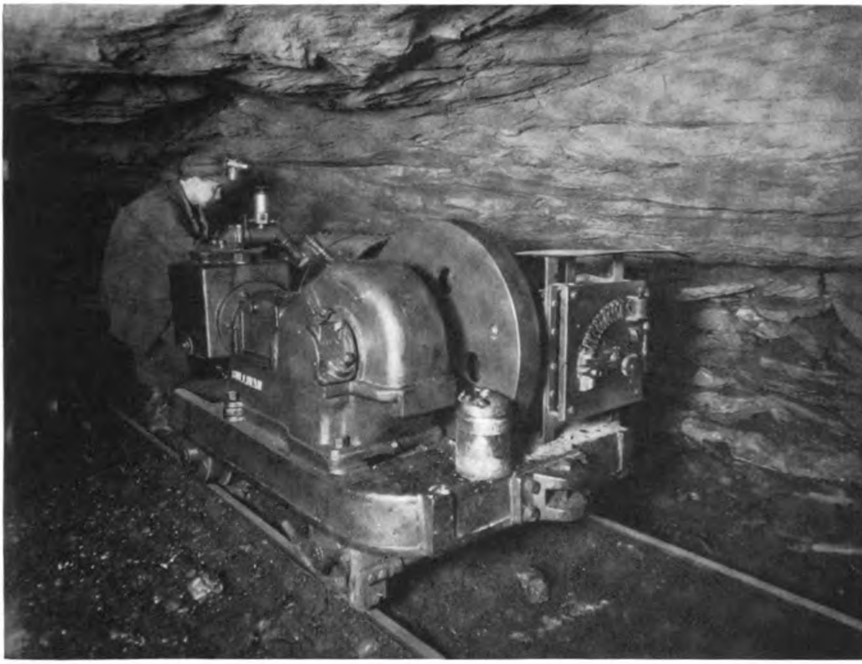
In trying out the new mounting, several rooms were drilled. One of these will serve as an example of the results secured. Five holes were drilled for a total of 27.1 feet, in 13 minutes 10 seconds drilling time, an average of 2.1 feet per minute. The drill and mounting were then pulled down, moved to a near-by cross cut, reset, and three holes drilled, for a total of 16.3 feet, in a total time of 17 minutes. The actual drilling time on these three holes was 8 minutes, 2 seconds. The drill was the standard Sullivan "DP-33" Rotator with hollow piston, using ⅞-inch hollow hexagon steel and "Z" bit. On the first hole two lengths of steel were used; on all others, one six-foot length only. The great time and labor economy of such a coal-drilling rig will be evident to the reader.

Many coal mines that are equipped with electric current for coal cutting and for haulage have installed one or more Sullivan portable motor driven compressors and a few Sullivan Rotators to drill their coal and to remove rock where it is encountered, in cutting overcasts, break-throughs, brushing roof, taking up bottom, or even for driving rock drifts. This compressor is mounted on a mine car which also carries the direct-connected motor and air receiver. The compressor is of the totally enclosed, dust proof, splash oiled, single stage pattern and is equipped with hopper cylinder jacket for cooling and an inlet valve unloader which saves power when the drills are idle. The outfit is practically automatic and





Telescopic mounting for drilling shot holes in coal with a Rotator Hammer Drill



Sullivan "WK-2" Portable, Motor-driven Air Compressor, for coal mine use

may be taken anywhere in the mine where rails may be laid and a feed wire strung. It is of course most effective when it is kept close to the drilling, so that pipe or hose lines are short. One of these units is shown on this page.

COMPRESSED AIR HELPS BUILD AEROPLANE MOTORS

By R. T. Stone*

The American Bronze Company at Berwyn, Pennsylvania, manufactures "NON-GRAN" bearing metal and bronze bearings of the highest quality, which are in great demand for use in automobiles and in aeroplane motors. The company operates a foundry in which the castings are made and a machine shop in which the bearings are finished off. In both of these departments, compressed air plays an important part in manufacture.

In the foundry it is used for sand blasting the castings, for operating moulding machines, and chipping hammers. In the machine shop, air is piped to the different machines and benches, and blowing hose is installed for cleaning the dirt and chips off of the machine tools, and for blowing off the finished work.

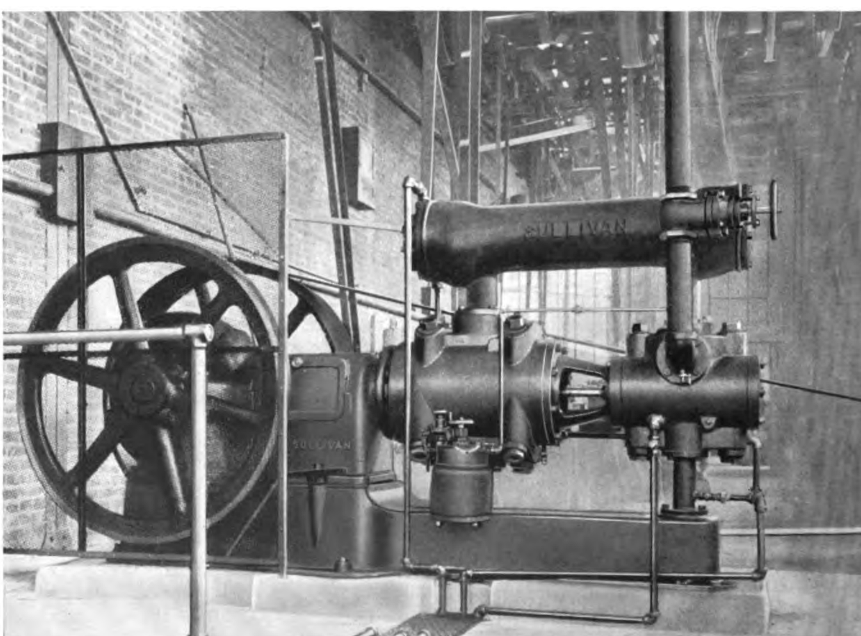
The photograph on the next page shows a Sullivan Air Compressor of new design, which was recently installed by this company to supply air power for the above purposes. This is a tandem, two-stage, belt driven machine, class "WH-3," with air cylinders 12 and 7½ inches in diameter by 10-inch stroke. The machine is operated by a 50 h.p. Fairbanks-Morse A. C. two-phase motor. The compressor furnishes compressed air at 90

*30 Church Street. New York City.

pounds pressure, and at its rated speed of 235 r.p.m. has a displacement of 306 cubic feet of free air per minute. At the time of writing, the requirements of the shop were not up to the capacity of the compressor, and the motor was temporarily fitted with a small pulley that drove the compressor at 180 r.p.m., at which speed it displaced 257 cubic feet per minute.

The compressor operates at constant speed, and although the load varies widely, the air pressure is maintained constant at the fixed pressure of 90 pounds per square inch, by means of an improved unloader. An interesting feature of this unloader is an arrangement for catching any oil or foreign matter in the air line, which would otherwise clog the pilot valve.

As shown by the illustration, the machine is of the enclosed frame type, with dust tight, removable covers over the main bearings and at each side of the crosshead guides, for inspection or adjustment. These main working parts of the machine are oiled by the splash system, while the air cylinders are equipped with sight-feed lubricators, making the machine practically automatic and requiring very little attention. An intercooler of the standard Sullivan aluminum or copper tube pattern is employed, the air being forced across the cooling tubes three times, by means of baffle plates, in its passage from the low pressure to the discharge cylinder. This machine is located in the machine shop, where a large number of men are at work, and a noisy machine would be intolerable. Both cylinders are equipped with improved inlet and discharge valves of the automatic poppet pattern, fitted with special double cushioned springs, and these are so quiet in operation that at a little distance their action cannot be detected. Low power consumption and simple, rugged construction are other advantages of this Sullivan compressor.



Sullivan "WH-3" Air Compressor at American Bronze Company's plant, Berwyn, Pennsylvania

CORNISH DIAMOND DRILLING

According to the best information available, no diamond drilling had been done in Cornwall, England, one of the oldest and most famous districts of civilized times, during the past ten years. At that time the Dolcoath Mine endeavored to do some drilling underground, using an English built diamond drill. After many mishaps they succeeded in drilling a hole 100 feet deep which cost £1100 or £11 per foot. This experience condemned diamond drilling as an absolute failure throughout the Cornish mining district. Late in 1916 Messrs. Bewick, Moreing & Co., the well-known British mining engineers, contracted with the Sullivan Machinery Company of London for diamond drilling to be done underground at the East Poole and Agar mines. In accordance with this arrangement the Sullivan Machinery Company assumed the responsibility for the success of the drilling, charging a fixed price per foot for the work. After several weeks' work, this machine was purchased by the mining company and has now drilled over 3000 feet. A bore of over 100 feet in length was put in a fortnight in very hard ground. Another drill, more recently furnished, is working two shifts per day at Dolcoath, averaging at least 20 feet per day. This work is in horizontal holes underground, 400 to 500 feet deep.

The annual report of the Geevor Tin Mines, Ltd., recently published, stated that —

"We undertook some diamond drilling. This was admirably carried out by the Sullivan Machinery Company of Chicago and we located certain lodes which were known to us and discovered two more which may some day, by cross cutting, prove to be of importance. But the crowning result of our effort was that we cut what we hope and believe is an extension of one of the famous Levant lodes."

In consequence of this drilling, the Geevor mines have been placed upon practically a new basis, and the shares nearly doubled in price on the market.

Work is also being done for the Rayfield Tin Syndicate, Ltd., at the Porkellis mines, and the success achieved by the Sullivan Diamond Drill in the hands of experienced operators has entirely changed the opinion of mining men in the Cornwall field regarding the practicability of this method of prospecting.

DIAMOND DRILLING AT PORCUPINE

More than 6000 feet of diamond core drilling was performed by the McIntyre Porcupine Mines, Ltd., at Schumacher, Ontario, during the fifteen months, from April, 1916, to June 30, 1917. Prior to this date these mines had done nearly 14,000 feet of work with diamond drills. The work done with these machines was of great assistance in indicating the extent of ore bodies and values. Hole No. 84 from the 1000-foot station of the main shaft penetrated, at a vertical depth of 1387 feet from the surface, 19 feet of $25.30 ore. Hole No. 91, drilled from the same level, penetrated 12.5 feet of $8.20 ore at a depth of 1160 feet. Hole No. 78, drilled to the northwest from the 300-foot level of No. 2 Jupiter shaft, passed through 7.5 feet of $13.50 ore at a vertical depth of 785 feet from the surface.

This sketch of Uncle Sam digging deep to help the Allies and to finance his new Army and Navy was received by MINE AND QUARRY from H. B. Quinan of our energetic contemporary, the *Mining Magazine* of London.

Do *your* part when the next call comes. "Go across or come across" is a good motto.

Balance!

THE balance of the reciprocating masses and movements in the horizontal and vertical members of

Sullivan Angle Compound Air Compressors

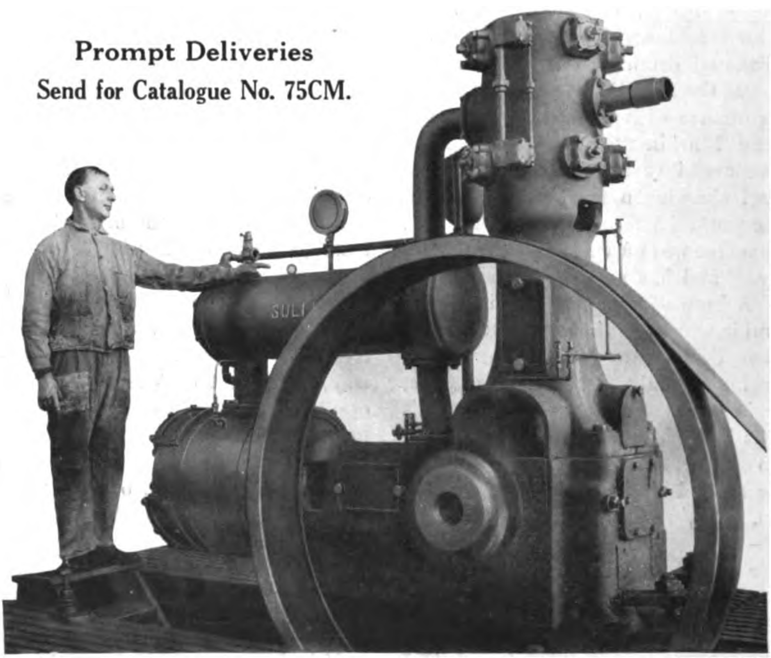
is so perfect that *a coin will stand on edge on the machine*, when running at full speed, without the foundation bolt nuts.

This balance and smoothness of operation saves foundation cost, permits lighter construction, smaller floor space and permits safe operation at high speeds.

Capacities from 400 to 1100 cubic feet—Twin units from 900 to 2600 cubic feet.

Prompt Deliveries

Send for Catalogue No. 75CM.



Sullivan Machinery Company

122 South Michigan Ave., Chicago, Ill., U. S. A.

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MINE AND QUARRY

REG. U. S. PAT. OFF.

VOL. X, No. 4 JULY, 1918 WHOLE No. 35

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American Sentries at a French Outpost
Shell Fire Destroyed this Post just after this Picture Was Taken

AIR IN A SHELL PLANT

CHOOSING THE RIGHT ROCK DRILL

MINING BLUE DIAMOND COAL

PUBLISHED BY THE SULLIVAN MACHINERY CO. 122 S. MICHIGAN AVE., CHICAGO.

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MINE AND QUARRY
REG. U. S. PAT. OFF.

VOL. X, No. 4 JULY, 1918 Whole No. 35

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address.

With the development of the light, self-rotating hammer drills, during the past few years, and their adaptation to many kinds of rock excavation, the tendency to use them for all kinds of drilling has been a strong and perhaps a logical one. Mr. Berteling's article on "Choosing the Right Rock Drill," in this issue, places a needed emphasis on the fact that there are many conditions in which the older piston drills are still most efficient. Choosing the right drill is a matter of engineering, as Mr. Berteling demonstrates. Sullivan drilling engineers are ready to place their experience at the service of drill users whenever or wherever it may be asked for.

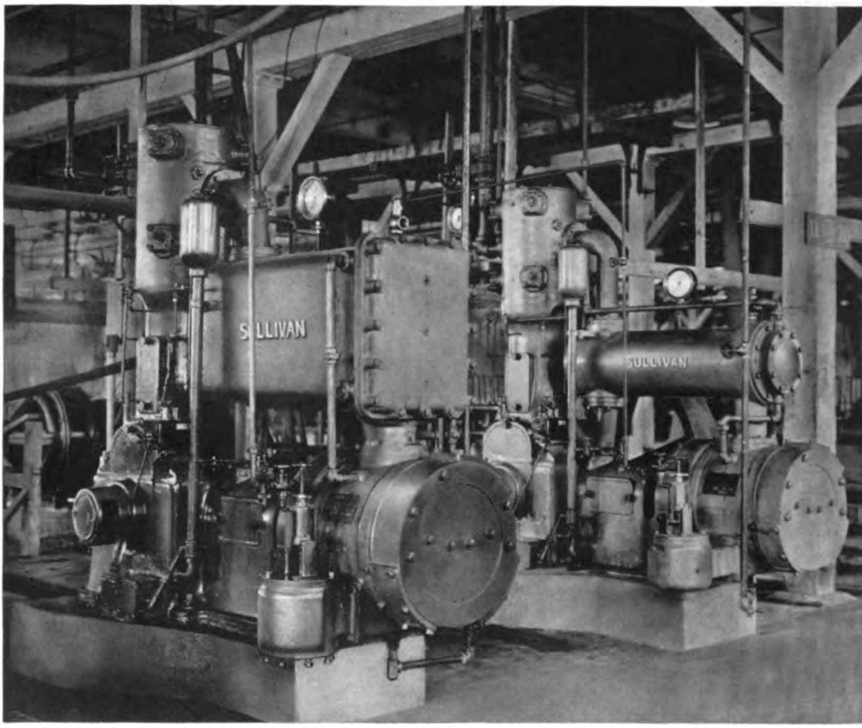
Better drill bits mean greater drilling speed and lower cost for ground-breaking. The application of common sense to forging drill steel results in reduced losses from steel burning and breakage, less expense for drilling machine repairs, less time lost in waiting for steel and spare parts, less labor in forging. Proper forging and sharpening methods thus mean economy, efficiency and conservation all along the line. With present scarcity of steel, and transportation delays, it will be more profitable than ever to make the most out of the steel you have. Encourage your blacksmith. Give him the best forging and sharpening equipment you can get, and adequate help. The entire overhead expense of your mine or quarry or contract is pyramided on your drill steel, and a small outlay at this point will bring large returns all along the line. In this issue appears the third installment of Mr. Gilman's paper on "Drill-Bits." In the next issue, his paper on "An Ideal Steel Sharpening Shop" will begin.

All who can should adopt the pledge proposed by the food administration: "I will eat no wheat until the next harvest."

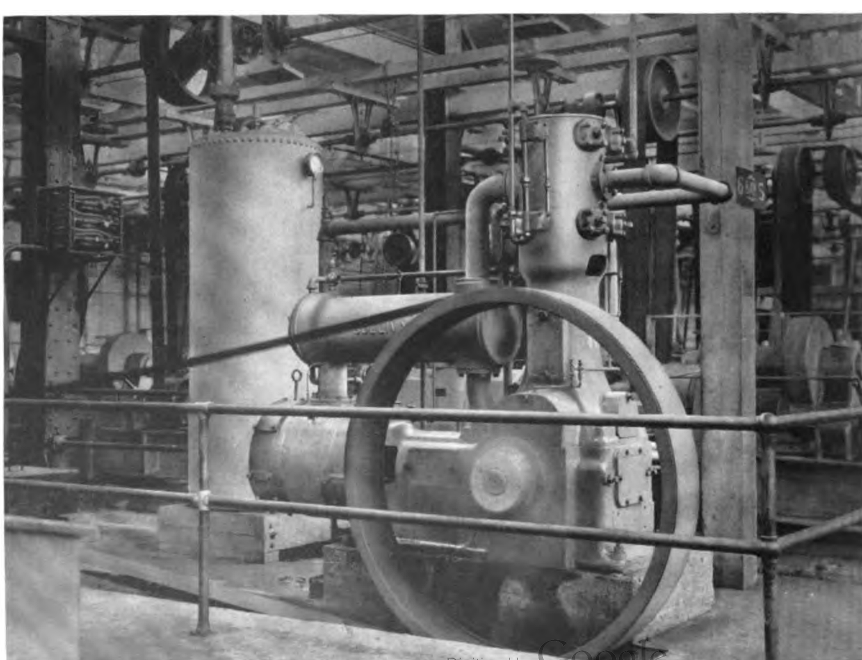
WHY YOU SHOULD SAVE

When you spend money, you pay for somebody's services and you pay for the material that is used to make the article you buy. If you buy things with your money that are actual necessities, you are spending your money in the right way; but if you buy things you do not need, you are taking the labor and material used in producing these unnecessary articles and are thereby preventing the use of such labor and material in behalf of our fighting force. It is therefore necessary to save in order to protect our Army and to win this war.

United States War Savings Stamps and Thrift Stamps are for sale at post offices, banks, stores, and many other agencies. Inquire at the office of your own concern or at the nearest post office or bank.



Two Sullivan Angle Compound Compressors, Rough Turning Department, Winslow Brothers Company



COMPRESSED AIR IN A SHELL PLANT

By R. E. C. Martin and S. B. King*

The convenience, adaptability and economy of air power for industrial and manufacturing purposes are well illustrated by its use in the manufacture of shells. In this field it is speeding up some operations, reducing the labor required for other jobs, and performing still other processes that would be difficult to perform by other means.

These uses are well demonstrated at the plant of Winslow Brothers Company at Chicago.

Before the war Winslow Brothers manufactured ornamental iron and bronze for architectural purposes, and enjoyed a national reputation in this business. Finding that their business was rapidly falling off, due to the inactivity in the building construction line, they decided to convert their plant and organization to the manufacture of war munitions. They have accordingly remodeled their entire plant, which occupies about 4½ acres on the West Side of the City, and have installed a large amount of new equipment especially adapted to manufacturing 155 millimeter shells. They have at present considerable contracts from the United States Government for high explosive shells for use in the heavy artillery howitzers.

The shell blanks are delivered to Winslow Bros. in the form of pressed or drawn steel forgings, cylindrical in shape, with one end closed, weighing about 180 pounds each. After machining, they are shipped from this plant, complete and ready for service, with the exception of the nose or fuse attachment. They are designed especially for containing "T. N. T." or Trinitrotoluol.

In undertaking the production of these shells, Winslow Bros. found their building layout well adapted, with certain minor changes, for the purpose at hand. Practically all manufacturing was formerly done on the ground floor of the plant, the tool making, drafting, pattern shops and store rooms being on the second floor. It was therefore possible to establish a storage yard, and an economical layout and routing of the work through the plant from storage yard to shipping room; so that the shells move forward from one department and one process to another with the least possible loss of time and motion. Rolling benches are principally used in handling the shells, with roller conveyors and belt conveyors for the longer transfers.

*People's Gas Bldg., Chicago.

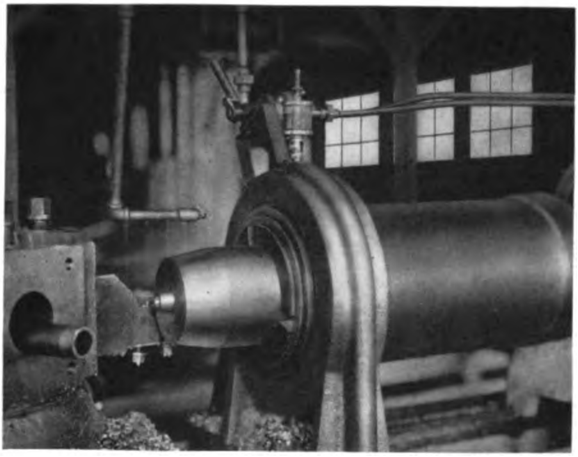
USE OF COMPRESSED AIR

The production chart of the company shows 47 different operations of normal manufacture, through which each shell goes on its way through the plant. In many of these, compressed air forms a time and labor saving agent of the first importance.

AIR CHUCKS

Air chucks of improved, standard pattern are used on practically all the lathes and boring tools for holding the work, and releasing it quickly. These processes include such as cutting off the end of the shell-blank, rough and finish turns, turning the nose and base to exact dimensions, turning the bourrelet, turning the waved groove near the base, on which the copper ring which engages the rifling is forced, turning the rifling knurls on the ring itself, and boring out the interior of the shells.

The use of air chucks, in shell manufacture, by means of which the chuck or clutch holding the work can be tightened or released instantly, has been one of the most important elements in cutting down the amount of time required in the turning



Air Chuck on a 155 M.M. shell lathe

process, and also saves considerable labor.

A lathe equipped with air chuck is shown in the photograph on this page.

SAND BLASTING

After the shells have been turned to exact dimensions, both inside and out, they are taken to the sand blasting machines, where the unevennesses left by the tool are carefully removed. The photograph on page 1053 shows a battery of revolving sand blasting machines, with the shells in position. Two cuts or stages of sand blasting are performed. A rough or preliminary blast is first given them and they are then finished on the machines shown, which put the final finish on the interior of the nose of the shell.

SODA WASHING

Compressed air is also used in the machine employed for washing out the interior of the shells. The shell is placed nose down over a nozzle, through which steam, water carrying caustic soda, or air can be discharged as desired to wash, dry and cool the interior. This process is useful to remove excess varnish, dirt, etc.

VARNISHING

On page 1054 is shown a photograph of the varnishing machines at work on shells. It would be a difficult and tedious job to varnish the interior of these shells by hand with the degree of care and evenness required. The machine shown is of the familiar air gun type. It consists of a spray, or head, on a spindle or pipe connected by hose lines with the air supply and with an overhead can for varnish. It does the work exceedingly rapidly and perfectly. The spindle travels forward into the shell, the varnish being sprayed onto the interior surface of the shell as the spindle is withdrawn. The shell is revolved in the meantime, so that an even coating of varnish is applied.

This is one of the last processes through which the shell goes before it reaches the final inspection by the government officials at the plant. It is then varnished on the outside, capped with a metal nose-cap, to prevent moisture from entering the shell, and delivered to the shipping department.

COOLING JETS

Compressed air is also used in the form of a jet to cool the primary windings of the shell band heating transformers or ring heaters. The copper band, when almost white hot, is forced by a powerful hydraulic press into the machined groove near the base of the shell. On these bands the ridges for engaging the rifling are subsequently machined. The jet of compressed air is applied through the base of the winding chamber.

Mr. Brunning, shop superintendent for Winslow Bros., is one of the joint designers of this type of heater, which is

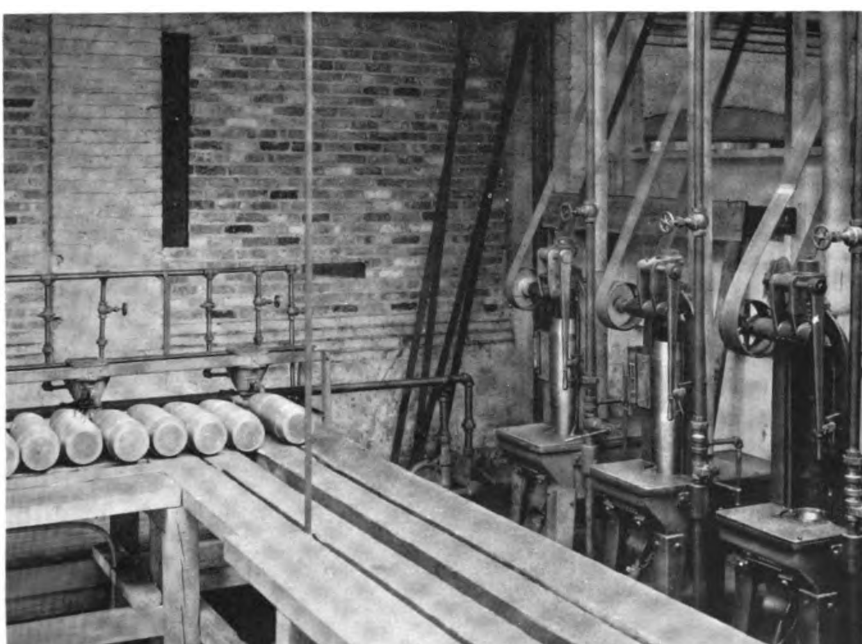
giving exceedingly satisfactory service. In this method the heating effect in the ring is obtained through energy "loss," which appears as useful heat. The bands are placed one at a time about the refractory, and in from two to five minutes, depending on the size of ring to be heated, the band is raised to a bright cherry red heat—at an expenditure of about two-thirds of a cent per band for current, based on a cost of one cent per k. w. hour.

AIR COMPRESSORS

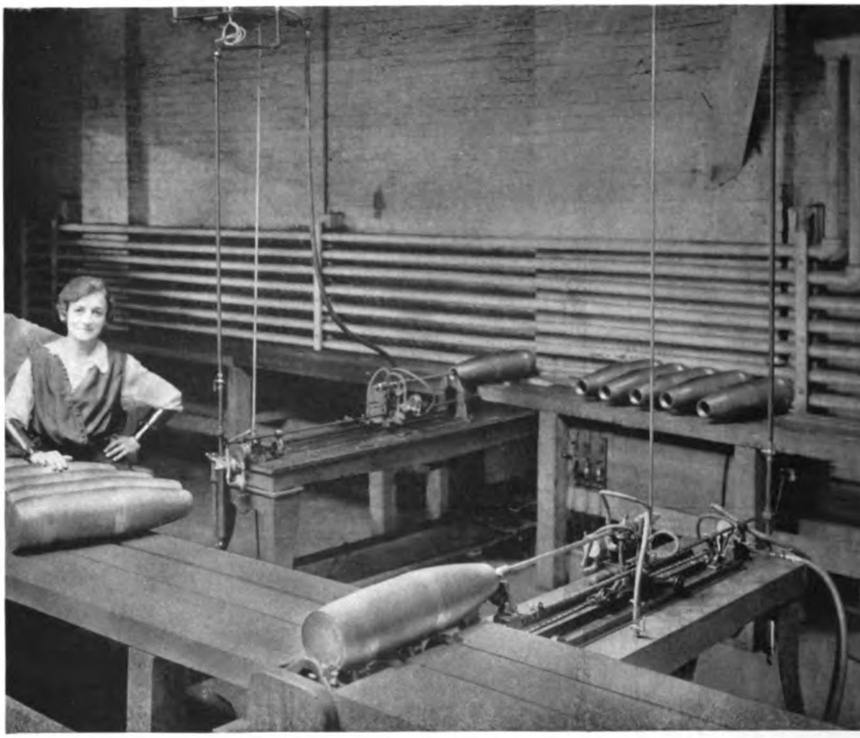
Compressed air for these several processes is supplied at the present time, by four Sullivan Angle Compound Belt Driven Air Compressors. These compressors are of uniform size, with low pressure cylinder 14 inches in diameter, high pressure cylinder 8¾ inches in diameter, and a common stroke of 10 inches. An interesting feature of the air installation, of which photographs are shown on page 1050, is the fact that instead of being grouped centrally in a power house, or engine room, they are distributed about the plant, at convenient points where the air is most used. This saves long runs of piping and makes for efficiency, as it obviates to the greatest possible extent drop in pressure, due to friction in the transmission line, caused by elbows and turns.

Air is compressed by these machines to 100 pounds pressure, and each unit has a rated capacity of 445 feet per minute at 250 revolutions. Each compressor is belt driven from a 75 horse power electric motor made by the General Electric Company.

The compact character of these installations will be noted from the photographs, also from the small size of the foun-



Sand Blasting Machines. The shell is placed upside down in the machine, the air blast coming from below. The soda-washing device, with three-way cocks for compressed air, steam or caustic soda solution, is shown at the left



Shells being varnished by compressed air

dation required. Two of the compressors are set side by side, as shown in the upper photograph, in the rough-turning department of the shop. The other two compressors are set singly in different parts of the finishing department at the other end of the plant. All are equipped with the improved Sullivan End Rolling Finger Plate Valves on both inlet and discharge openings of high and low pressure cylinders. As equipped with these valves, the compressors operate noiselessly and with minimum vibration. The angle compound construction lends itself to this effect by the exact balancing of the horizontal and vertical reciprocating parts.

In order to save power and secure as high operating efficiency as possible, these compressors are equipped with the improved Sullivan Three Pass, Counter Current Intercoolers, of unusually large cooling area and effectiveness. In these intercoolers there are three independent sets of tubes through which the cooling water passes, and the air is forced across the tubes in their three separate chambers successively; so that the temperature of the air, when it finally enters the high pressure cylinder, is but very little above that at which it entered the low pressure or intake cylinder.

By using relatively small units in this manner, future expansion of the plant and its air requirements can be taken care of in the most economical manner possible. That is, if additional lathes or sand blasts are needed later on, additional compressors on their compact foundations can readily be installed, to take care of the

increased air power requirements at the exact point where the air is most needed. Should space become an important factor, these machines can be equipped with close center drive, cutting in two the total area required for the compressor and motor installation.

Receivers of ample capacity are installed close to the compressors. A 700-foot aftercooler is also provided for the compressor that furnishes air to the sand blasting machines and varnishing sprays. It is effective in providing dry air, which is essential in sandblasting the interior of the shells.

Winslow Bros. have organized this new enterprise with a large degree of foresight and with the intention of not only using the most approved manufacturing methods, but of catering to the safety, comfort and well-being of their employes to the fullest extent possible. Safety devices are provided for all dangerous operations and instructions are carefully posted, so that accidents may be avoided. A "first aid" room, with a competent trained nurse in charge, is a feature. An unused court yard has been converted into a play field, where basket ball and volley ball can be enjoyed by employes. A number of women are already at work in the Winslow plant and more are to be taken on as the work advances. Those at work in the manufacturing processes are dressed in uniform bloomer suits. A cafeteria dining room for both men and women has recently been established and there is a separate and attractive rest and change room for the women, with a matron in charge.

The company is increasing its facilities and expects to work up to a maximum output of 4000 155mm. shells per day, or 100,000 per month. A clock face, 16 feet in diameter, is erected at a central point in the works, where all employes and officers can follow the progress of the hand toward the goal of the desired output.

The officials of this company, Messrs. W. H. Winslow, F. A. Winslow and Edwin S. Fechheimer, regard their present enterprise as an opportunity of first importance to help win the war, and they have this aim and object before them at every stage of their operations. The son of Mr. W. H. Winslow, Alan F. Winslow, will be recalled by readers of MINE AND QUARRY as the first American Army aviator to down a Hun pilot, as reported in newspaper dispatches of several weeks ago.

The officials of the company have associated with them a body of competent and experienced engineers and production men in this industry. Mr. D. L. Derrom, works manager, has had great experience in organizing shell manufacturing plants, and in producing shells and munitions in Canada during the past three years, and it is due to his skill and experience that the Winslow plant owes many of its improved features for rapid and economical manufacture.

Mr. Brunning, general superintendent, is co-inventor of the shell band heater described above.

Acknowledgment is tendered to these officials for their courtesy and assistance in securing the photographs and the above information.

LAYING THE DUST OF DRILLING

New regulations will come into force on August 1st, in Great Britain, providing for the use of a jet of water to be directed onto the cutting edge of the drill bit, in all mines, in which ganister, or other rock containing 80 per cent or more of silica, must be drilled. Provisions are also made, for damping rock of this character after blasting, to prevent the scattering of dust in the mine air; and when such rock is broken up for loading it must be effectively dampened by covering with wet brattice cloth, etc. Additional regulations will also go into force regarding ventilation and water supply in these mines.

IMPROVED SHARPENER DIES MAKE BETTER DRILL BITS

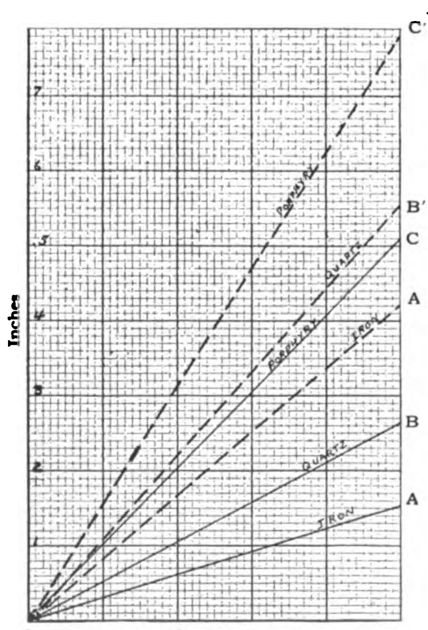
By Howard T. Walsh*

The increased efficiency to be obtained by proper forming and treating of drill bits is so marked and so little attention is paid to this end of the ordinary day's work by mine officials, that one is lead to believe they do not realize what can be accomplished with very little effort on their part.

Some are beginning to give their drill steel situation serious consideration and are paying dividends from this end of their work, which they little believed possible.

The attached chart shows results that were accomplished by one of the largest copper mines in this country. Lines OA, OB, OC, show drilling speed in inches per minute obtained with their standard, machine sharpened drill bits using ⅛-inch changes in gauge.

Lines OA', OB', OC', show results obtained by using bits with proper reaming edges and faces and a 1/16-inch change in gauge.



Distance drilled with different bits

* 122 So. Michigan Ave., Chicago.

In addition to increased drilling speed their steel breakage has decreased from 10.5 per cent to 1.5 per cent and the amount of footage obtained from each steel before resharpening was increased 50 per cent.

The cut, page 1057, shows the vertical gauging dies as furnished with Sullivan Sharpeners for forming bits with correct reaming edges and faces. These dies are equipped with a positive gauging device arranged for 1/16 changes in gauge.

If any mine official will go into this situation carefully, he may expect approximately the following results:

Increased drilling speed from 40 to 100 per cent.

Decreased steel breakage.

Increased footage from each steel sharpened.

Lower sharpening costs.

Less time lost underground.

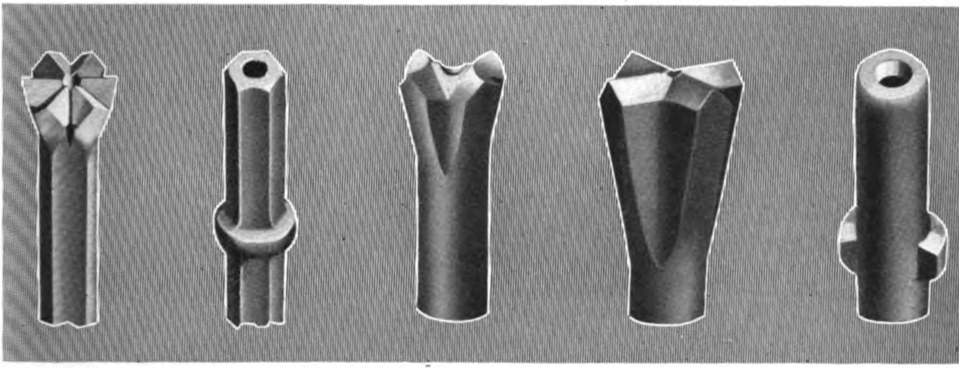
Life of drilling machines increased.

An extra minute used in the drill shop is better than fifteen minutes wasted underground. This waste can largely be avoided.

Don't try to see how fast you can make drill bits, but how well you can make them. You will have saved much labor in the end.

In using the gauging dies shown in the cut, the bit is upset in the clamping die by the horizontal hammer and dolly in the usual manner. The vertical dies are adjusted to the proper gauge by means of the key and thumb screw. The proper gauge, reaming edge and wing taper are applied by hammer action under the vertical swaging hammer. Changes in gauge for the different steels in a set are made in a few seconds.

The popular "bull" bit, the familiar "cross" bit or the new and efficient



Standard Bits and Shanks that may be made on the Sullivan Drill Sharpener. From left to right: "Rose" bit on hexagonal steel; "Rotator" or collar shank; "Double Arc" bit; cross bit; "DR-6" or lugged shank

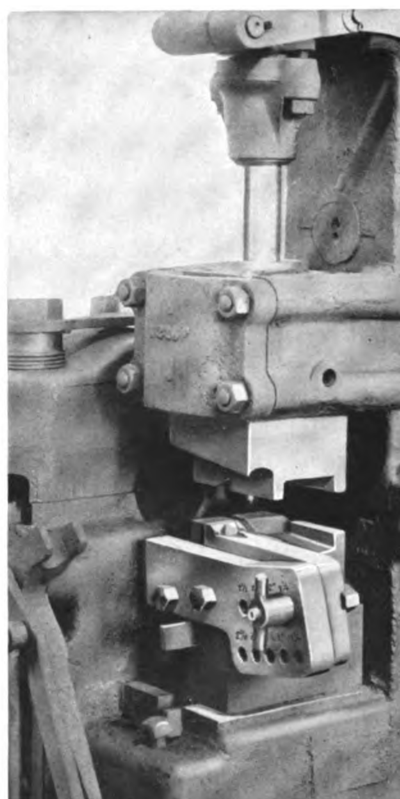
"double arc" bit can be made in these dies rapidly and cheaply. The all-hammer process and the alternation between the dolly and vertical swages compacts the metal and improves its wearing quality.

The Sullivan Machinery Company announces the establishment of a Washington, D. C., branch office, Room 210, Union Trust Building, corner 15th and H streets. Ralph T. Stone, associated with the New York Office of the Company, is in charge of local interests in Washington.

The Lake Superior Branch of the Sullivan Machinery Company, Jonathan A. Noyes, district sales manager, has been transferred from Ishpeming, Mich., to Duluth, Minn., and is now situated in the Alworth Building, Room 311.

NEW PUBLICATIONS

IRONCLAD COAL CUTTERS: Bulletin 73—48 pages. Describes Sullivan Ironclad Continuous Cutting Mining Machines, "CE7" and "CH8," for room and pillar and long wall workings, for D. C. or A. C. electric drive; "Permissible," government-approved, explosion-proof Ironclads, for gaseous mines; also Turbinair Ironclads.



Adjustable Gauging Dies in position on the Sullivan Sharpener

Tipple and loading facilities. Blue Diamond Coal Company

THE BLUE DIAMOND COAL COMPANY

By W. S. Hutchison*

The Blue Diamond Coal Co's operation is located in Perry County, Ky. at Blue Diamond. It is three and one-half miles from Typo on the First Creek Branch of the Lexington and Eastern Railroad. First Creek empties into the North Fork of the Kentucky River at Typo.

On June 16, 1915, members of the Blue Diamond Company began prospecting their present property. Outcrop openings warranted further testing and a contract was entered into with the Sullivan Machinery Company to diamond core drill the property. The results proved satisfactory and in the fall of 1915 actual development of the property was begun, while in June, 1916, the company loaded its first car of coal.

The property comprises approximately 3000 acres of coal-bearing land. The principal seam, known as the No. 6 seam is now being developed by the company. Four other seams also lie on the property and are known as the Nos. 4, 5, 7, and No. 8 seams.

The No. 6 seam averages five and one-half feet in height and is a hard, clean, blocky, bituminous coal. It has a heavy sand rock top and a hard, smooth fire-clay bottom. The seam is uniform throughout, the track grades being practically level. The elevation of the seam above creek bottom is 150 feet and above sea level 1180 feet. Approximately 500 feet of mountain covers this measure. The coal shows an ash content of 3.5 per cent and a sulphur content by analysis of 0.5 per cent. It is used and marketed for steam and domestic purposes and has recently met with high favor in the malleable iron trade.

TWIN MINES OPENED

Twin mines are being developed, one on each side of the creek valley. The mines are being worked on the room and pillar system. The rooms are driven 20 feet

*709 Market Street, Knoxville, Tenn.

and 36 feet wide and 250 feet deep. The 20-foot rooms are driven near the outcrop and the 36-foot rooms where the overburden is heavier. Thirty-foot pillars are left where driving 36-foot rooms and 25-foot pillars are used where the rooms are 20 feet wide. The pillars can be split and robbed back should this method become necessary.

The double and triple entry systems are used at both mines. Main entries are driven triple and cross entries double. Fifty-foot pillars are left between entries and 100-foot barrier pillars protect the main entries. All entries are driven 12 feet wide.

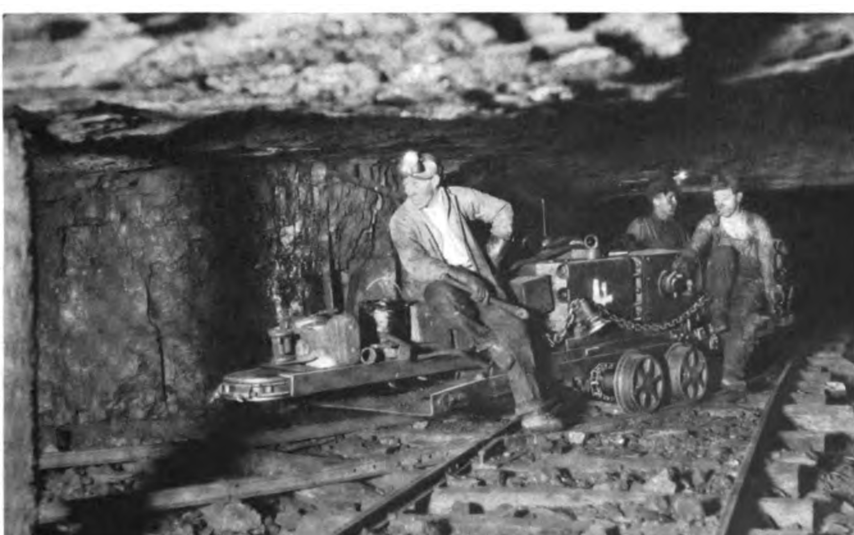
COAL CUT BY IRONCLADS

The output at present is about 1600 tons per eight-hour day. The coal is all undercut before it is shot and loaded. All undercutting is done with the latest type Sullivan continuous mining machine known as the "CE-7 Ironclad." The machines are equipped with 250-volt D. C. motors and 6½-foot cutter bars. The average output of the Ironclads is 200 tons each per eight-hour shift. They are used in undercutting all rooms and driving all entries, break-throughs, and room-necks; the coal being of such a character that shooting from the solid is not satisfactory and hand mining is practically impossible. The machines average 10 places per eight-hour shift, approximating six rooms and four narrow places. Recently a runner cut 21 places in ten hours' time, including the time used in moving from place to place. This run included three 36-foot rooms and 18 twelve-foot places.

In blasting the undercut coal, in twelve foot entries, three shots are used, one on each rib and one in the center. The holes are drilled to a depth of six feet and about 18 inches of black powder is used in each hole. The coal is drilled with small electric post drills.

ROTATORS DO ROCK WORK

A Sullivan Class "WK-2" portable electric driven air compressor and a Sullivan "ROTATOR" drill, Type "DP-33" are used on all rock work. This out-



Sullivan Ironclad and crew moving; note permanent roadway

Sumping a Sullivan Ironclad Coal Cutter. Blue Diamond Coal Company

Sullivan Ironclad Cutting across the Face

fit is considered one of the most economical units on the job. It is used principally for drilling rock in overcasts, and for removing top and bottom; but is frequently used for cutting hanger holes and for cleaning machines. The portable compressor is a complete unit in itself. The compressor, receiver, motor and starting apparatus are all mounted on the same base which serves at the same time as the body of the truck. The air cylinder of the compressor is provided with a large water jacket of the hopper type. This plan of cooling the cylinder is simple and keeps the temperature of the air cylinder at a safe point at all times. The "DP-33" drill is self-rotating, has automatic lubrication and weighs but 38 pounds. A mining column with a cradle or shell mounting is used with this drill at this mine. The column and cradle are used when putting in high holes. As the cradle weighs but 60 pounds, the unit constitutes a "one-man" outfit. The drill averages a six-foot hole in six minutes, which includes setting up and changing steels. Actual drilling tests made at this mine in solid sandrock show many six-foot holes put down in four minutes apiece.

HAULAGE AND POWER

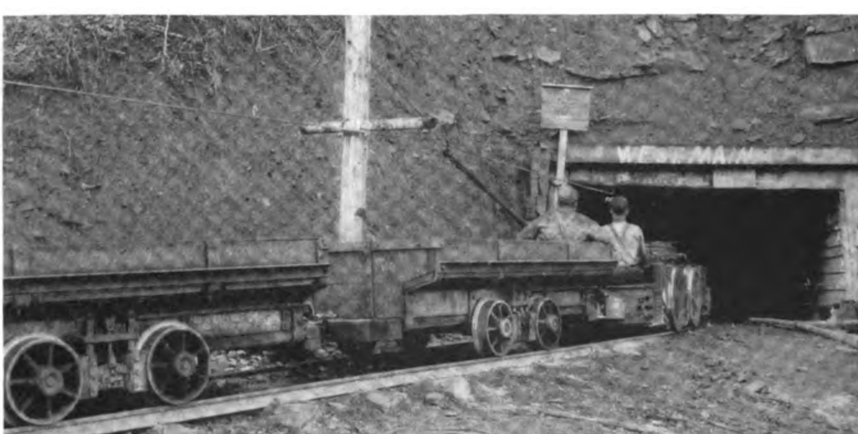
Due to the unusually favorable grades the haulage problem here is a simple one and a six ton locomotive is the largest used. The mine cars weigh 2700 pounds and carry an average load of two and one-half tons. The track gauge is 48 inches. Forty-pound rail is used on the main haulage entries, 25-pound on cross entries and 20-pound rails in rooms.

The company purchases power from the Kentucky River Power Co. At present they are equipped with two 150 K. W. motor generator sets and will soon install another. The sub-stations are located close to the mine mouths, holding the line loss to a minimum.

PREPARING AND LOADING

A modern, all-steel tipple was erected early in the development of the plant. The tipple has a capacity of approximately 3500 tons per day. The screening equipment is very complete and any grade of coal can be prepared by changing the screen plates. The tipple is provided with picking tables and loading booms for the larger sizes of coal. A box car loader is also part of the tipple equipment.

The coal is dumped from the mine cars



West Main Opening, Blue Diamond Coal Company. Electric locomotive entering the mine

Sullivan Ironclad loading itself onto its power truck

by rotary dumps (see page 1063). Number 1 Mine is equipped with a single-car rotary and Number 2 Mine with the same style and type of dump, but of two-car capacity. At No. 1 Mine a loaded car carrying 2½ tons of coal is run onto the dump, automatically clamped and unloaded by completely revolving. This dump has a capacity of unloading four cars per minute. The coal after being dumped from the car goes by gravity into the conveyor which leads down the mountain to the tipple house. The conveyor is so equipped with retarding devices that coal is carried to the tipple house with a minimum of breakage. The dump houses are on the tram road grade and the coal is brought from these points to the tipple by means of conveyors. The conveyor on No. 1 side is of the disc type and on No. 2 side a drag type conveyor was

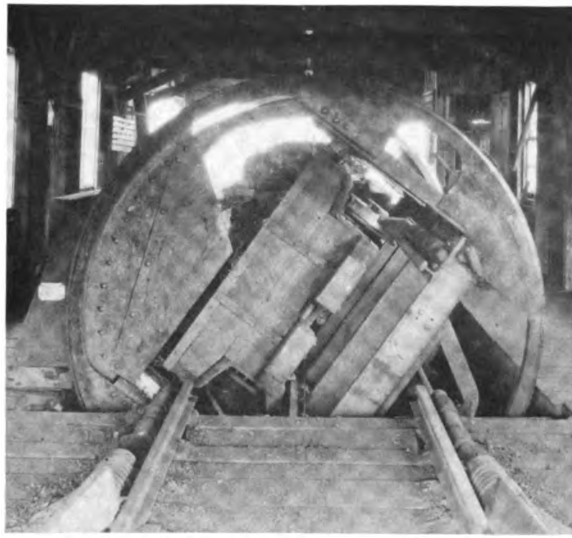
A car of machine mined coal

installed. Both types give very satisfactory service.

AIR AND WATER SUPPLY

Centrifugal mine fans are installed and the split system of ventilation has been adopted. At present the permanent fan installations have not been completed but two small 30-inch fans furnish ample air for the development to date.

The camp is supplied with water from a well operated by a motor-driven, geared deep well pump. The water is pumped to a 20,000-gallon tank on the mountain-side and distributed through the camp by gravity. A 25,000 gallon tank is also located on the mountain side and is filled by gravity flow with mine and surface water. This tank can be used in case of fire or other emergencies.



A car of coal in the rotary dump

WELFARE FEATURES

The welfare of the company's employees is the first consideration. Splendid graded schools are provided for the children and a high school is contemplated. A Y. M. C. A. building is under construction. It will include a moving picture theater, bowling alleys, pool and billiard tables, reading rooms, etc.

Mr. Alexander Bonnyman is president of this company and the other officers are Calvin Holmes, vice president, Joseph Richards, general manager and H. H. Braden, superintendent. Undoubtedly the success of this company has been due to the efficiency and co-operation of its personnel.

The writer is indebted to the above gentlemen for the assistance rendered in preparing these notes.

Coal is received direct from the conveyors for preparation on these shaker screens

A well-stocked commissary provides for the needs of the Blue Diamond Coal Company's employees (see preceding page)

The Boston Office of the Sullivan Machinery Company moved July 1 to Room 516, Boston Safe Deposit and Trust Bldg., 201 Devonshire St. George E. Wolcott is manager.

"The ship on which I sailed has arrived safely overseas. George W. Blackinton, Major, 353d Inf., 89th Div. American Expeditionary Forces" (Received July 1, 1918.)

IRRIGATING FLORIDA FRUIT BY THE AIR LIFT

By John Oliphant*

The accompanying photograph shows the orange and grapefruit grove of Richard C. Lake at Clearwater, Florida, in which water supply for irrigation purposes is furnished by means of the air lift system. Mr. Lake's grove comprises about 80 acres of land; water for irrigation purposes is provided from a single well 15 inches in diameter and 310 feet deep. At the head of this well is a receiving basin made of reinforced concrete, 11 feet in height and 8 feet square, which gives the necessary drop for discharging the water to the different parts of the plantation. The water is carried from this basin in terra cotta mains, some of which are 12 inches, others 8 inches, in diameter, aggregating 12,000 feet in length. At intervals along these mains are diversion boxes with gate valves by which the flow of water into the mains can be regulated. The picture on page 1065 shows the flood basin surrounding one of these diversion boxes, and in the background another diversion box and basin, and still farther off the square tank at the well. The pipes are sunk to a depth of 14 inches below the ground.

Shallow furrows are run from the valves in various directions, conforming to the slope of the land.

Along the lateral mains, valves with 5-in. openings are placed at the surface of the ground at distances varying from 40 feet to 50 feet, from which the water is allowed to flow and is conducted where desired.

Water is pumped from the well by means of a Sullivan Air Lift System, including the following equipment:

1 Sullivan Straight Line Two-stage Steam-driven Air Compressor, Class "WB-2," the steam cylinder being 12 x 14 inches, low pressure air cylinder 14 x 14 inches, and high pressure air cylinder 9 x 14 inches. This machine has a capacity of 396 cubic feet of free air per minute at 160 revolutions per minute, and requires 70 boiler horse power for its operation.

1 vertical steel air receiver, 6 feet long by 30 inches in diameter.

1 Central Type Sullivan Air Lift Pump of latest design, with 6-inch discharge line and 2-inch air line.

1 Central Umbrella Well Top with 7-inch discharge and 2-inch air connection.

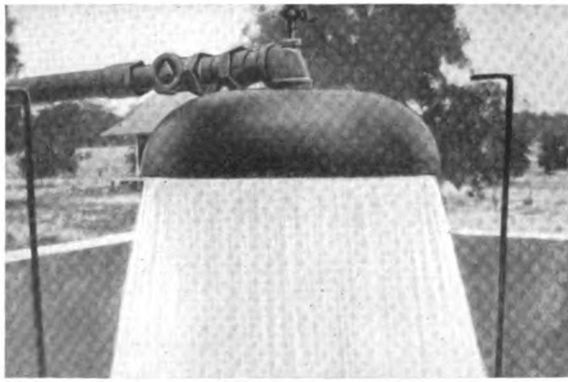
The piping in the well is as follows:

Water discharge line,
148 feet of 7-inch butt-jointed pipe.
148 feet of 6-inch pipe, part butt-jointed, part standard.
292 feet of 2-inch standard air line.

*Chief Engineer, Pneumatic Pumping Department, Sullivan Machinery Company, Chicago.

The following table shows the conditions under which the test was run on this well:

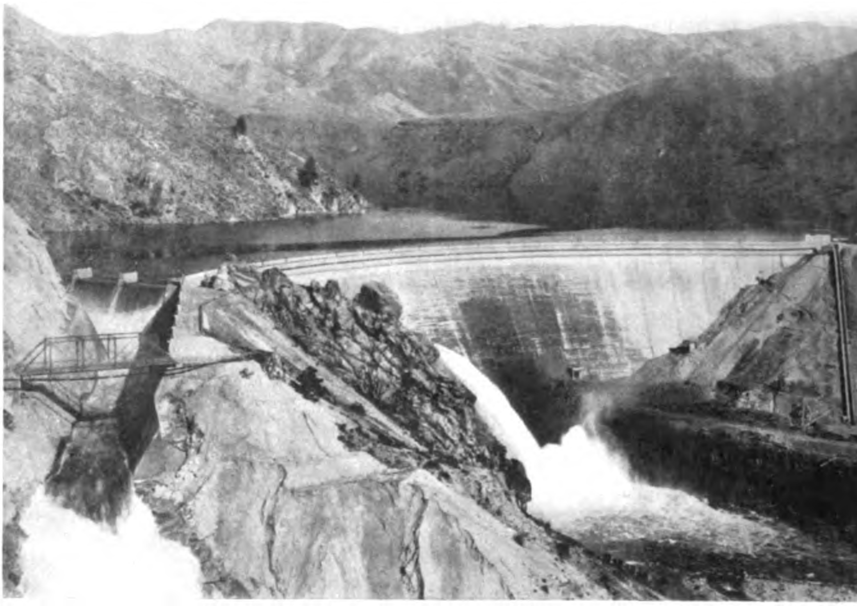
Depth of well	310 ft.
Diameter of well	15 in.
Static level (when not pumping)	72 ft.
Drop (when pumping)	5 ft.
Elevation (above ground level)	11 ft.
Total lift	88 ft.
Submergence 70 per cent	204 ft.
Compressor operating speed	144 r. p.m.
Displacement at this speed	351 cu. ft.
Volumetric efficiency of compressor	86%
Actual air at above speed and efficiency	302 ft.
Gallons per minute	875
Cubic feet free air per gallon	.345
Water pressure	89
Friction, 950 feet 2½-inch pipe compressor to well	3 lbs.
Operating pressure	92 lbs.
Indicated h. p	61
Water h. p	19.5
Overall efficiency	32%



Discharge from Central Sullivan Air Lift Pump into receiving tank

The amount of water which it was estimated would be required was 600 gallons per minute. It will be noted that the plant produces 875 gallons of water per minute, an output of 26.6 gallons per square inch of effective discharge area in the 7-inch pipe, and of 38 gallons per square inch of effective discharge area in the 6-inch pipe. Considering the excessive friction caused by pumping this amount of water under the conditions of the installation, the efficiency of the system is unusually good.

Fruit grove of Mr. Richard C. Lake, Clearwater, Florida, showing irrigation system, a diversion box and gate valve in the foreground



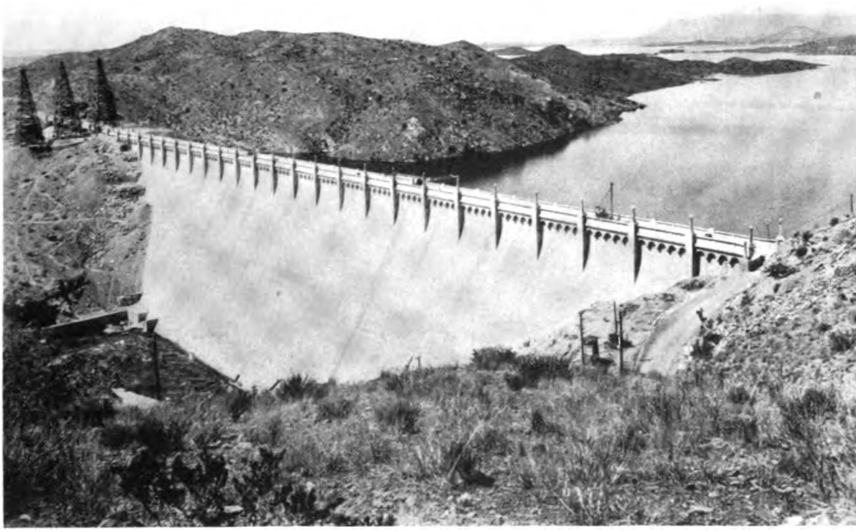
Arrowrock Dam, Boise Project, United States Reclamation Service, Idaho

SAFETY FOR TWO GREAT DAMS

The excellent photographs on these two pages (furnished by the United States Reclamation Service) illustrate the completion of two of the most notable Government irrigation projects in this country, the Elephant Butte Dam in New Mexico, some 125 miles north of El Paso, on the Rio Grande River, and the Arrowrock Dam, on the Boise River, in Idaho. Each of these dams has a particular claim to distinction, the former impounding the largest volume of water of any similar structure in the country, and the latter being the highest dam in the world from crest to foundation. Each possesses many features of interest for readers of MINE AND QUARRY on account of the methods used in construction. The following table shows some facts of interest regarding these huge enterprises:

(From the "Reclamation Record," October, 1917)	Elephant Butte Dam, N. Mex.	Arrowrock Dam, Idaho
Height, from base of dam, below river bed.....feet	318	348.5
Length, on top.......feet	1,310.7	1,060
Maximum width, at base ....feet	215	223
Width, on top........feet	18	16
Length of reservoir...miles	45	18
Maximum depth of foundation below original river bed (approximate)..feet	100	90
Total available capacity of reservoir.......acre-feet	2,638,860	280,000
Time of construction...yrs.	5¼	5¼
Total cost...............	$4,260,150	$3,830,735

The United States Reclamation Service did not enter on the construction of these public works, which are intended to be as permanent as the pyramids of Egypt or the roads and aqueducts of Rome, without studying the proposed locations in a most thorough manner. The geological formations for miles up and down the Rio Grande and the Boise were investigated and every factor carefully weighed, so



Elephant Butte Dam, Rio Grande Project, United States Reclamation Service, New Mexico

that not only should the sites finally chosen conform physically to the requirements, but that no fault, seam or weakness in the rocky bed or below it should endanger the completed structures.

Between five and six years were spent by engineers of the United States Reclamation Service in these investigations. As the selection of sites narrowed, Sullivan Diamond Drills were brought into play, and with them numerous core borings were made along the cliffs and in the beds of the streams. The cores removed were systematically filed in order and their indications charted.

As a result, the engineers were assured, before they authorized the expenditure of a cent for construction work, that the finished dams would never be undermined by leakage, or destroyed by sliding or washouts.

A complete account of the Arrowrock Dam and its construction appeared in MINE AND QUARRY for August, 1913. Sullivan Rock Drills were used in excavating the river bed, the diversion tunnel, and the spillway.

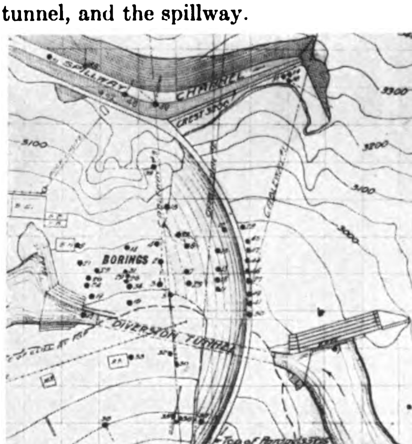


Chart showing Diamond Drill borings at site of Arrowrock Dam. Each dot indicates a test core hole. Sixty in all were drilled here

Sullivan Liteweight Rock Drill drifting in a Northern Michigan iron mine

Drifting with a Sullivan "DR-6" Mounted Water-Hammer Drill

CHOOSING THE RIGHT ROCK DRILL

By John F. Berteling*

During the past few years, competition among drill manufacturers has resulted in very active development and in the designing and manufacture of many new types of rock and hammer drills. It is not many years since all kinds of drilling work were done with the standard piston machines using solid steel and mounted on tripods or columns. With the 2¾ or 3⅛-inch piston drill, holes were put in in all directions and to all depths possible under different conditions. Of late years special machines have been developed for special conditions, and in many instances the field for the different types of machine overlaps.

AN ENGINEERING QUESTION

There is, then, need for care and engineering study in the selection of the proper type of drill, for a given purpose and for given conditions. This has become an important problem and one calling for extended knowledge of the different classes of machine drills, and of the work and ground for which they are adapted. While the drill problem may appear to be more complex than ever from the standpoint of the customer, the selection of the drill which is actually best suited for his requirements, will very rapidly repay him for the effort made and any expense involved in testing machines.

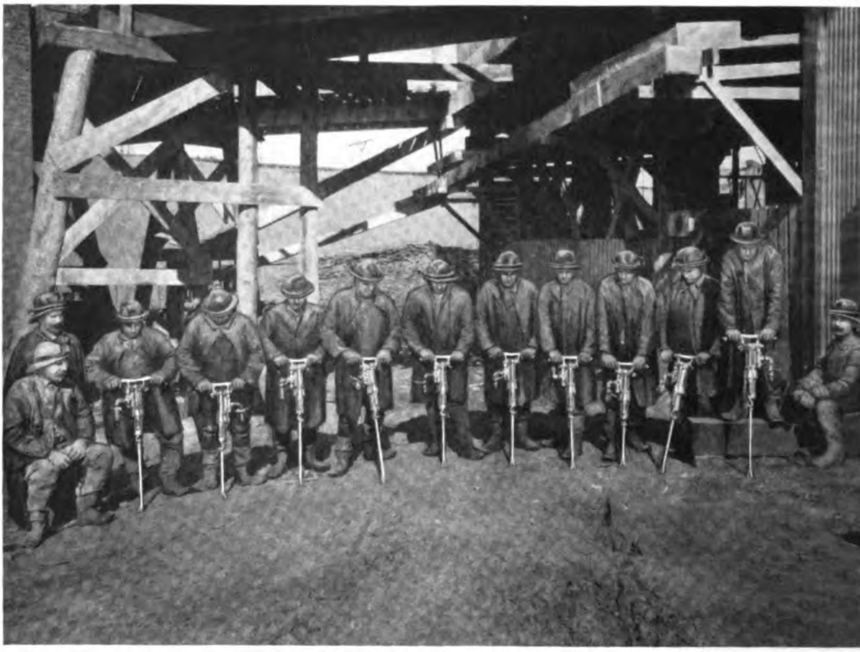
Below are given a few instances of fitting the drills to the job, which may prove of interest to readers.

As stated above, in many instances the field for the different types of drilling machines overlaps. When the user states that new machines are to be bought for doing certain work, a certain type of machine may come to mind, but investigation may show that conditions are such that the machine which apparently is the proper one may be inadequate on account of some limitation or other.

WHEN HARD-HITTING DRILLS ARE NEEDED

At a certain Gogebic Range mine in northern Michigan, drills were to be selected for shaft sinking. On the face of it a self-rotating hand-feed hammer drill, using hollow steel and an air jet to clean the hole, of the Rotator pattern, would have appeared the proper machine to use. After a trial of hand-feed hammer drills and water jet mounted hammer drills, Sullivan Liteweight 3¼-inch drills with solid piston and using solid steel were employed. The ground was solid jasper and in this formation no machine now available can cut fast enough to make the problem of removing the sludge a serious one. As the holes in shaft sinking are all down holes and as the shaft made some water, the introduction of water into the drill holes did not have to be considered, so that hollow steel possessed no merit for the job. The light hand hammer drill could not touch the ground at all. Its limitation, and that of the mounted water hammer drill, was that they did not strike hard enough. With both machines difficulty occurred with the steel, as the gauge showed a wear of one-eighth of an inch in drilling four inches, and this would have required a 3⅝-inch starter to drill a six-foot hole for 1¼-inch powder. The use of a starter of such gauge would have further reduced the drilling speed. The 3¼-inch Liteweight drill, using a three-inch starter, struck a blow of sufficient force to cut the ground, and nine or ten inches could be drilled with one piece of steel before the gauge was lost. In this ground in a drift, even with steel of larger gauge than that used by the water hammer machine, the Liteweight would drill something over an

*Newport Mining Company, Bessemer, Michigan.



Sullivan Rotators used in sinking the Woodbury shaft, Newport Mining Company, Ironwood, Michigan

inch a minute, as compared with 0.8-inch per minute for the water hammer drills.

Under these conditions the prime requisite was a machine that would strike a blow hard enough to cut the ground.

CLEANING THE HOLE IMPORTANT

In some formations it is not a question of cutting the ground, but of removing the cuttings from the hole. In the sinking of the Woodbury Shaft at the Newport Mine at Ironwood, Michigan (described in the January, 1916, Mine and Quarry), which, so far as learned, was sunk in world's record time for a shaft of its size and depth, granite was the formation encountered. This shaft was 22 x 13 feet outside the timbers. Hand-feed self-rotating hammer drills of a certain type were used for the first four months. After the first month's work, it was found that a round of holes, which would include cut holes ten feet deep would increase the sinking speed. The hammer drills were found to fall off rapidly in drilling speed after the holes reached the depth of six feet, because they did not clean the hole well. A blowpipe was used but involved loss of time. Rotator hammer drills of the Sullivan "DP-33" type, fitted with an air jet attachment, were found to drill ten-foot holes rapidly and without using a blowpipe. These machines cleaned the hole effectively, and solved the drilling problem. The shaft was sunk 2150 feet in twelve months. The best month's record, made with the Rotators, was 201 feet.

PISTON DRILLS FOR SUB-STOPING

At a mine at Alpha, Michigan, sub-stoping is the method of mining in use. In sub-stoping, very little timber is used, which to begin with, will give the

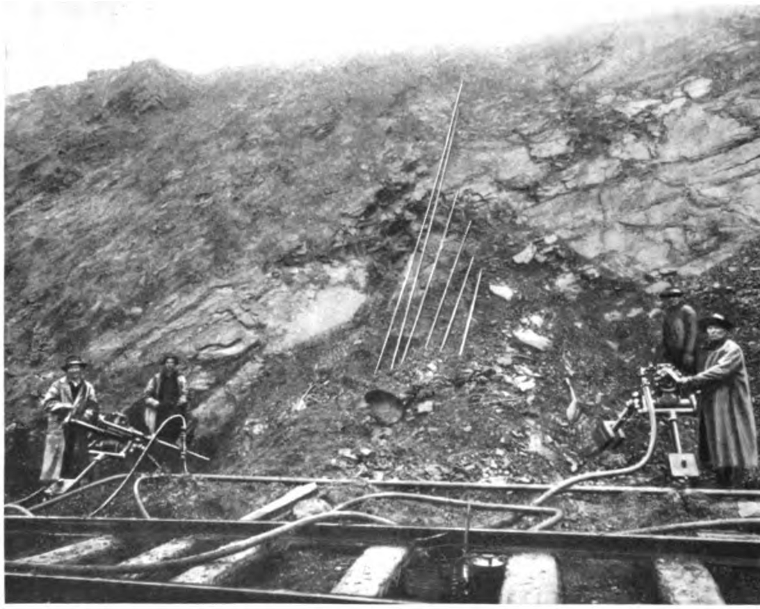
reader an idea of the firm character of the ground. This method could not be used if the ground did not stand up well. Sub-levels about twenty feet apart are driven to raises and machines are mounted at the mouths of the sub-levels. Holes are drilled up about ten feet, to the side ten feet in depth, and down about ten feet; the same work being carried on on each sub-level. Drill engineers were invited to recommend the best machine for this work. At that time solid steel piston machines of two types were in use. A trip underground disclosed the fact that these drills were putting in the back holes quite rapidly, although even on these holes a steel would occasionally be stuck, as the ore contained some moisture and the cuttings would pack a little bit in the holes. More trouble was encountered in drilling the flat holes to the side to the depth of ten feet, as the cuttings packed in the bottom of the hole and water could not be forced down to the bit with a squirt-gun. On the down holes, after four feet had been drilled a blowpipe had to be used at every change of steel, as the sludge was heavy. Two drills were put in on trial, a mounted hammer drill with water jet attachment, and a 2⅝-inch Liteweight piston drill, with water attachment and using hollow steel. During a week's trial, the latter machine averaged a foot per minute of reciprocating time for all holes, whether up, flat or down, which was about 100 per cent better than could be accomplished with he hammer machine

On the back holes neither machine had any trouble. The mud ran from the hole freely and the drilling speed was high. On the flat holes some trouble was encountered by the hammer machine in cleaning the hole at depth. Steels were occasionally plugged and some difficulty was encountered with steels being stuck in the hole, due to caving and hard pieces lodging behind the bit. On the down holes the hammer machine never finished a ten-foot hole, while these holes gave no trouble to the water piston machine. Here we have a case in which cleaning the hole was of supreme importance, as the ground was not excessively hard. Air alone would not clean the holes, as the ore contained some moisture and the cuttings were sticky. Air and water *would* clean the hole, as the air did not have to move the sludge too far. Air and water and the reciprocating action of the bit did clean the hole to ten feet.

In drilling in ore, unless it is very solid, there will generally be a tendency for the collar of the hole to cave on the down holes. This happened frequently at the mine in question. On the down holes, particularly with the hammer drill, steels were often stuck in the hole. With the reciprocating machine this trouble was not encountered, as the reciprocating action was powerful enough to break up the particles of caved material, and with the combination of water and air to keep the hole clean and the steel free.

DRILLING 16-FOOT DOWN HOLES IN CAVING GROUND

Reciprocating water drills of 3⅛-inch piston diameter, Sullivan "FL-12" Liteweight pattern, proved their adaptability in an open pit mine at Iron Mountain, Michigan. The ground is quite hard and the material is laid down in layers at an angle of about 70° from the vertical. This means that in drilling the steel has a tendency to get out of line and the ground has a tendency to cave. It was desired to drill down holes 16 feet deep, about 12 feet back from the face. Heavy duty hand hammer drills, with water attachment, were tried as well as the piston machines referred to above. In hard ground, if the hole caves behind the hammer drill bit, the steel generally remains in the hole until the round of holes is blasted, and especially so when there are no lugs on the steel to permit rotation while it is being pulled back. This is what happened when the



Sullivan Rock Drills putting down 30-foot toe holes on Lewis Hole Tripods, Wakefield Iron Company's open pit, Gogebic Range, Michigan

hammer drill in question was tried. Some of the hard material caved, and the side of the pit still contains some 1¼-inch hexagon steel, which was stuck. A lighter drill was tried, but could only drill holes eight feet deep, one inch in diameter at the bottom. These eight-foot holes had to be drilled about six feet from the face. In a line of eight-foot holes, properly sprung and loaded, 1000 cubic feet would be broken by four such holes, while two sixteen-foot holes would break twice the amount. In this case the lighter hand-hammer drills would get a head start when work began in the morning, but by noon, once the 3⅛-inch water piston machine was mounted and under way, the footage would be about the same for the two drills, owing to the fact that the piston drills seldom encountered difficulty with stuck steel. To drill a sixteen-foot hole in this ground, the bit on a ⅞-inch steel would have to be so large to take care of the loss in gauge that the drilling speed could not be considered. The reciprocating water machines were selected after one day's demonstration.

TRIPOD DRILLS FOR PIT WORK

The photograph on this page shows another use of heavy piston drills on tripods. These were in operation at the Wakefield Pit, of the Wakefield Iron Mining Company, on the Gogebic Range. The drilling is in rock, and holes were drilled 30 feet deep, some vertical and some horizontal. The upper part of the formation is shattered and weathered. Under this broken surface the rock is hard. Much of this drilling was done during freezing weather. The use of mounted hammer drills was under consideration, but, upon recommendation by other engineers, 3⅝-inch water piston machines with hollow steel and auxiliary valve, of the Sullivan Hyspeed type, were selected.

These were mounted on Lewis Hole tripods, which are equipped with a planed and slotted front bar. These tripods were recommended on account of the ease with which the steel could be changed. The machine was simply barred out of the line of the hole, the steel pulled out alongside of the drill and the fresh steel replaced in the same manner. This obviated displacing the tripod and losing the alignment of the drill with the hole. On account of the fact that much of the work was done during freezing weather, the use of water was out of the question. It was recommended that air be by-passed through the water tube to clean the hole. Hollow steel was difficult to obtain at the time the work was started and solid steel was used. All holes were drilled horizontally or slightly above horizontal at the bottom of the face of rock to be removed, instead of vertically as originally planned, and the work of the machines was found to be highly satisfactory for holes up to thirty feet, the required depth. The operation of these machines was so successful that a similar equipment was purchased for the adjoining Coates and Tweed property.

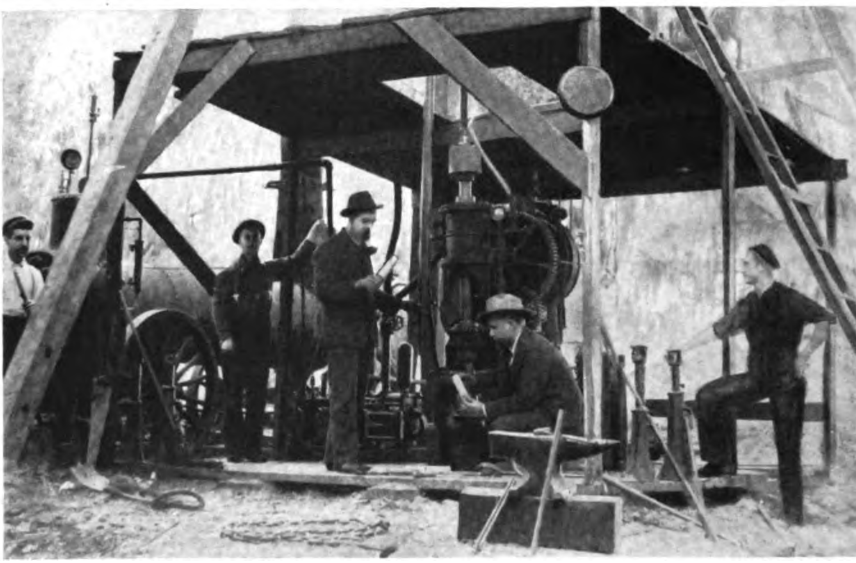
SELECTION OF HAMMER DRILLS FOR DRIFTING

On the Marquette Range, drills had to be selected to drive a 1000-foot rock drift. This formation was solid, but not very hard. With a 2½-inch water hammer drill, a six-foot hole was drilled in about twenty minutes. The mounted Sullivan Rotator, with water attachment equalled the drilling speed of the larger machine on account of the smaller bit. One man was used on each drill. Under these conditions a piston machine would have been out of the question, as the reciprocating action was not needed to clean the hole and a piston machine, to drill as fast as the hammer drill, would have had to be considerably heavier. Hard rock was to be encountered, as indicated from the ground passed through on the upper level. Sullivan "DR-6" Water Hammer Drills were recommended and purchased. With the harder ground and higher air pressure which was to be furnished, it was apparent that this machine would drill faster than the Sullivan Rotator with smaller changes and less lost time.

The above are merely a few samples of drilling problems which are constantly coming up wherever mining is done or rock removed. It has been evident that the field for the different types of machines overlaps and that the selection of a drill depends on special requirements of the conditions, such as cleaning the holes, with the piston machine, where a hammer drill fails; the necessity of using a larger piston machine, on account of its powerful stroke, in very hard ground, and the importance of using steel with lugs, or collars in connection with hammer drills when caving ground is encountered to lift the steel out of the hole when stuck on account of caving.

These examples have indicated, among other things, that there is still an important field for the older or piston drills, and that while in very many instances the newer and lighter types of hammer drills will undoubtedly give the best service, it is not merely a question of selecting the latest model of drill, but of fitting the drill to the ground and the work to be done.

In passing it may be said that the piston machines, which gave the results as mentioned above, are "old" drills only in the matter of general type. Sullivan Piston Drills have been carefully redesigned recently, and such features as the Liteweight steel cylinder lining and the auxiliary valve motion of the Hy-speed machine indicate a degree of perfection and economy of the same character as those found in the latest examples of the hammer type of drill.



Sullivan Diamond Drill boring for salt on Jefferson Island

DIAMOND DRILLING FOR SALT

That Joseph Jefferson, the great actor, who made Rip Van Winkle live for three generations of Americans, ever had anything to do with mining, or with Sullivan Diamond Core Drills, will be a surprise to many readers of MINE AND QUARRY. Jefferson Island, a few miles from Petit Anse, La., was owned by Mr. Jefferson, and in about 1893 he was anxious to bore for water. He had actually given a contract for the well but the contractor found difficulties in complying with the terms of his agreement owing to the boulders and sand through which he had to drill. At this time, Mr. Jefferson called in the services of Mr. Anthony F. Lucas, the famous mining engineer, who is identified in the mining profession with the development of the Beaumont Oil Fields and of the famous Beaumont Gusher in Texas. Mr. Lucas was mining engineer of a salt mine at Petit Anse at that time. He says in an interview in *Mining and Scientific Press* for December 22, 1917, "I accepted eagerly and helped by introducing a method of driving the casing, and succeeded in assisting the contractor to pass through the gravel bed. About 100 feet deeper we struck what appeared to be solid rock, but, upon analysis, it proved to be an enormous bed of salt. Then Mr. Jefferson asked me if I would continue the exploration in an advisory capacity, which I did. I purchased a Diamond Drill from the Sullivan Machinery Co. of Chicago and drilled to the depth of 2100 feet, still in salt. A total thickness of 1750 feet of salt without encountering any foreign substance. I was proceeding nicely and was anxious to find the floor of the salt when he stopped me at 2100 feet, thus balking a possible study in geology, for I wanted to learn on which geological formation this salt was resting. On subsequent borings I found that the salt mass was in one locality only 81 feet from the surface."

Tremendously valuable salt deposits remained in the hands of Mr. Jefferson and his heirs until recently. The photograph on this page shows the Sullivan

Diamond Drill, a class "P," at work on Jefferson Island. Captain Lucas is the man sitting down behind the anvil, examining a core just removed from the drill. The standing figure with the beard is John Cole, a veteran Diamond Drill superintendent, who had charge of the drilling work. Cores 2 inches in diameter were removed with the double tube core barrel.

DRILL BITS AND DRILL STEEL. III.—SELECTING, FORGING AND TEMPERING

By George H. Gilman*

[The proper shape of drill bits and their development were discussed by Mr. Gilman in two previous chapters, appearing in the August, 1917, and February, 1918, issues of Mine and Quarry. Copies will be sent on request. The entire paper was first published in the *Engineering and Mining Journal.*—Editor.]

IMPORTANCE OF QUALITY OF STEEL

Too much importance cannot be attached to the problem of determining the quality of drill steel that is best suited for the ground. The best drill steel is not necessarily the highest priced, nor is a cheap steel the best for all conditions. In general, it may be said that the best steel to employ for a fixed set of conditions is the steel that will withstand the duty imposed upon it without undue breakage and will withstand the abrasive action of the rock with the least amount of wear.

Hollow drill steel, which is now generally used throughout the United States in combination with hammer rock drills embodying an air or water jet for the purpose of ejecting the sludge or rock cuttings from the bottom of the drill hole, is a comparatively new departure in steel making, and the manufacturers have experienced some difficulty in meeting the requirements, owing chiefly to the fact that the hole throughout the length of the bar introduces (especially in the high-carbon steel) difficulties of manufacture that have not been easy to overcome; and for this reason it is a generally accepted fact that hollow drill steel is more susceptible to breakage than solid steel of corresponding sectional area. However, there are now on the market many excellent hollow drill steels that may be procured in a great variety of shapes and sizes.

The chemical composition of drill steel is a matter that has been subjected to a great deal of experiment by the drill-steel manufacturers, the mining industry and the manufacturers of rock drills. It is an accepted fact that steel of a low carbon content will withstand more abuse by the blacksmith and lends itself more readily to welding than steel embodying a greater percentage of carbon; on the other hand, it has been determined by experience covering a great many years that the higher carbon steel will better withstand the vibratory shocks to which it is subjected in hammer-drill service, and furthermore, the cutting bit, although requiring more care in the working and tempering, may be made to last much longer than is possible with the lower carbon steel.

The following specifications for straight carbon hollow drill steel to meet average conditions of ground and air pressure conform with present-day practice:

CHEMICAL COMPOSITION

	Per Cent
Carbon	0.85 to 0.90
Manganese	0.30 to 0.40
Phosphorus	Under 0.03
Sulphur	Under 0.03
Silicon	0.10 to 0.20

*Chief Engineer Pneumatic Drill and Channeler Department, Sullivan Machinery Company, Claremont, N. H.

The forging heat of this steel should not be higher than 1600° F. The quenching heat should be approximately 1300° F. (critical or decalescence point). To secure this result the hardening furnace should be set to secure a heat of from 1420° F. to 1440° F.

The following specifications for drill steel as applied to workmanship of the bar stock are fair and reasonable to both the steel user and to the manufacturer:

"Bars shall be free from injurious defects, shall have a workmanlike finish, and shall not be defaced by stamping, melt numbers or symbols except within 4 inches of one end of bar.

"The outside diameter of bars must not exceed the ordinary commercial limit of stock of this nature and must not be more than $\frac{1}{64}$ inch under or over the specified size. The hole throughout the length of the bar must come within the following limits:

Size of Drill Steel, In.	Size of Hole: Minimum Diameter, In.	Size of Hole: Maximum Diameter, In.
7/8	1/4	5/16
1	9/32	11/32
1 1/2	3/8	7/16

"The hole must be of such size and shape that a steel ball of the size specified by the minimum limit may be passed throughout the entire length. It must not exceed in area that of the maximum limit, and in the case of the hole being elliptical the long diameter must not exceed the diameter of the maximum limit plus $\frac{1}{16}$ inch. The hole must not be more than $\frac{1}{32}$ inch off center from the axis of the bar, and sharp corners in the hole, seams, flaws or cracks in the bar will be sufficient cause for rejection."

THE DRILL-STEEL SHARPENING SHOP

No man on the job deserves more consideration than the drill-steel blacksmith, for upon him depends in a great measure the entire success of drilling. A few minutes' carelessness by a blacksmith may undo many days' work of a careful steelmaker. Underheat in hardening naturally results in a soft drill steel, while uneven heating or heating for too short a time will result in a soft center bit with danger of breakage when the steel is put into service. Present-day practice is sounding the death knell of the old-style coal or coke forge for heating rock-drill steel for forging and tempering, and it is being rapidly supplanted with the gas or oil furnace, which has a great many points in its favor, chief among them the fact that it may be adjusted to approximately maintain the proper temperature in the heating chamber and thus obviate overheated or burnt drill steel.

A word of caution should be introduced against the common practice of allowing the bits to remain in the furnace longer than is necessary to bring the heat up slowly and uniformly to the desired temperature, which in practice is commonly termed "soaking." This has a tendency to open the grain of the metal by enlarging the crystals and produces brittleness. The blacksmith should handle his steel in rotation by advancing each steel one step nearer the point of withdrawal when a new drill is inserted.

The furnace is preferably constructed with baffle plates or surfaces to insure the maximum heat of the blast being directed against or over the drill bit just prior to the point at which it is withdrawn from the fire. The number of steels that can be heated in the furnace at one time is determined by the time required to bring the heat of the bit up to the proper point and the speed at which it is withdrawn for forging or tempering. It is desirable to both forge and temper drill steel on the rising heat, which necessitates the steel being withdrawn from the furnace the instant the required heat is obtained.

Gas as fuel is recommended where it is accessible and cheap, as it is the cleanest and costs least for installing. If oil is

used, it is desirable to have the oil-storage tank below the level of the burner, as the fire risk is lessened. A satisfactory grade of fuel oil may be procured at current prices ranging from three to five cents per gallon.

In isolated districts a great many of the mine blacksmith shops are equipped with home-made furnaces, the burner only being purchased outside. A sketch of such a furnace, which may be made at comparatively slight expense with equipment to be found in the average smith's shop is shown in Fig. 16. If a pyrometer is used for determining and checking the heating furnace, a base-metal outfit is recommended on account of its simplicity and the fact that its upkeep is slight. The pyrometer should be checked periodically. If the base-metal couple is used, one of the fire ends can be kept as a standard and the fire end in daily use compared with this standard. Each month or so a new fire end can be used for the standard and the old standard put in daily use. The indicator or galvanometer should be adjusted daily for the zero reading. If the temperature of the cold junction of the fire end is determined with an ordinary thermometer, the indicator can be adjusted to this temperature.

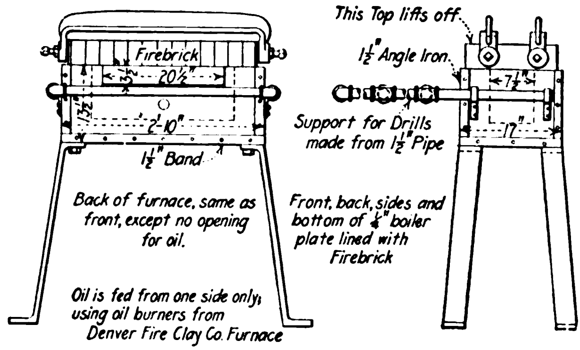


Fig. 16. Oil-burning Drill-Heating Furnace

For drill steel of the carbon content specified, the forging heat should not exceed 1600° F. The forging operation should not be continued after the steel fades from a good red color, as working a steel cold (below its critical range) distorts the refined structure and tends to produce brittleness. It is better to reheat the steel to finish the forging operation than to chance a bit or shank breaking underground.

Too much emphasis cannot be placed upon the desirability of forging the bit and shank end of the drill steel by subjecting it to percussive action instead of squeezing the part into shape on the principle of the bulldozer. Drill-making machines are now on the market utilizing the hammer blow for both upsetting and swaging. This method approaches more closely the results secured from hand-sharpening, which blacksmiths know is advantageous to the standing-up qualities of the bit. It furthermore permits the forging operation to be done at a comparatively low heat, as the conductivity of a rapidly reciprocating swage hammer has been found to be considerably less than that of a squeezing die.

For all hollow drill shanks equipped with a collar or lugs, the length from the shoulder to the striking end should not be more than $\frac{1}{16}$ inch over or under the specified size, and all transverse dimensions should not vary more than $\frac{1}{64}$ inch in either direction from the size specified. (See Figs. 14 and 15). The striking end should be kept square and smooth, with both the inner and outer edges slightly rounded. The hole in the shank for the reception of the water tube should invariably be kept central and open to the size specified, for a distance of from 3 to 3½ inches from the tip. This hole in the smaller sizes of hollow drill steel should not be less than $\frac{5}{16}$ inch and in the larger

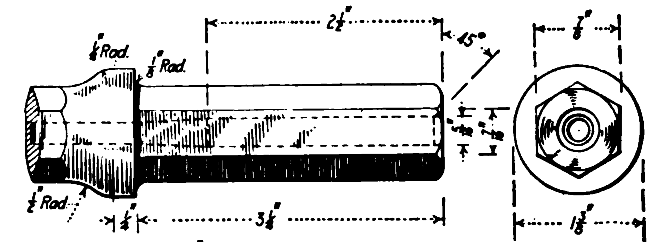


FIG. 14 STANDARD ⅞" HEXAGON COLLARED DRILL SHANK FOR "ROTATORS"

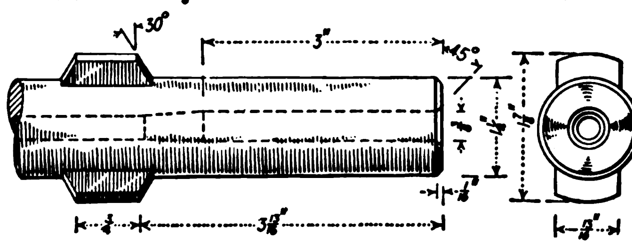


Fig. 15. Standard Lugged Drill Shank for Mounted Hammer Drills

sizes, 3/8 inch; otherwise a great deal of trouble will be experienced by broken water tubes.

DEVICE FOR KEEPING HOLES IN SHANK AND BIT OPEN

For large installations it is recommended that a pneumatic punch be provided for punching out the hole in both the shank and bit end during the forging operation. A number of successful devices have been developed for the purpose. A sketch of such a pneumatic punch is shown in Fig. 17, which, in general principle of design and operation, has been adopted by a number of the mining companies in the Southwest. Briefly, it consists of an air cylinder with its piston and piston rod, to the front end of which is detachably secured a taper punch of the required size. Compressed air is admitted to the front and rear piston chambers by a four-way plug valve under the hand control of the operator. Directly at the rear of the air cylinder is a cushion cylinder with its piston attached to the extension piston rod of the air cylinder. This cylinder is filled with oil, which is displaced from one end to the other through a small bypass connection. Forward of the air cylinder is a clamping device with suitable gripping jaws for the drill steel. This may be made hand-operative or equipped with an air cylinder and piston connected by a toggle with jaws, which assists materially in minimizing the manual operation. With an apparatus of this kind steel may be punched satisfactorily while hot, in from four to five seconds.

PYROMETERS AND COMPASSES TO DETERMINE PROPER HEAT FOR TEMPERING

Whatever the grade of carbon drill steel adopted, it is essential that the critical or decalescence point be determined to assist the smith in securing and maintaining the proper heat at which the material may be hardened and tempered to the best advantage. It is called the critical point because it is the point in the temperature of the piece being heated at which a change takes place in the structure of the steel due to the carbon being dissolved. It is the point below which steel will not harden when quenched, and by coincidence it is the point at which the steel loses its magnetism. For the purpose of illustration, take a bar of drill steel about 10 inches long and nick it in six or eight places spaced equidistant, to make breaking easier. Put one end in the furnace and heat it to nearly a white heat, letting the heat gradually run out to a dull red at the opposite end of the test piece and

then quench it in cold water. Now break the piece at each nicked place, and it will be found that the fracture that is closest and finest grained was nearest to or at the critical point. A skilled smith may thus determine this point by experiment and gauge the heat by taking note of the color, but this method is unreliable unless a check is provided, for oftentime the eye gets "off color," being influenced by the degree of surrounding light and the physical condition of the operator. It may be determined by means of the pyrometer, because when the steel reaches the critical point, it absorbs an abnormally large amount of heat. For instance, if we were to insert a pyrometer into a piece of steel being heated in a furnace, the temperature would be found to rise at a uniform rate until the critical point is reached, when its rising temperature is suddenly halted by the physical and chemical changes that take place in the steel, which cause it to absorb a certain amount of heat energy. In cooling, this condition is just reversed and a piece of steel cooled through the critical point will be found to give out a considerable quantity of heat. While the pyrometer method is reliable, the following, which may be adopted as a check, is perhaps more practical for the average mine smith.

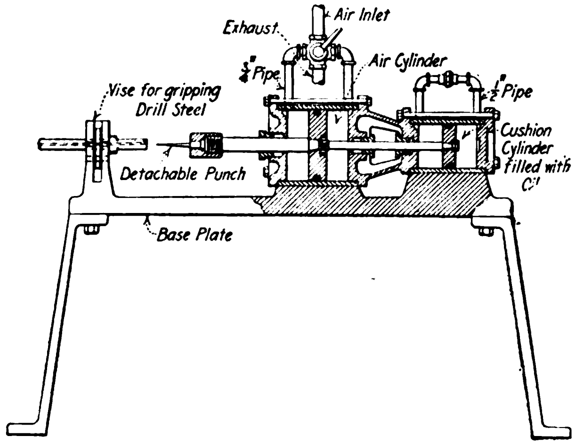


Fig. 17. Punch for hollow Drill-steel Bits and Shanks

A small pocket compass, preferably with a jeweled needle and stop, which may be procured in almost any jewelry or hardware store at nominal cost, and a pair of brass or other nonmagnetic tongs are the only essentials. This compass should be set upon a wooden stool in close proximity to the forge and in such a position that the natural swing of the test piece back and forth, when testing, will be in a plane at right angles to the needle. In other words, the test piece being hardened should be swung, using the brass tongs, east and west. By passing the test piece forward and backward close to the compass, the magnetism of the metal will cause the needle to be deflected first one way then the other and will continue to deflect the needle until the proper heat for quenching has been obtained. The right heat is reached when the material loses its magnetism. It does not follow, if the needle remains stationary the first time you test, that the heat is right, because after the material has reached a certain degree of heat the magnetism leaves the steel, so there is no influence on the needle and it may be too hot. Different grades of drill steel having different carbon content require different degrees of heat. The magnetism leaves the steel at that degree of heat corresponding to the carbon content in the steel, and in every case this is the proper heat for dipping. After testing, the smith may, by remembering the color, give the bit a corresponding heat, quench it in the bath to harden it and temper it by subsequently

subjecting the cutting end to the proper heat, by drawing the temper required to give the bit the necessary toughness for the work.

For tempering the finished bit, it should be heated slowly and uniformly until the critical point is reached and then quenched in the bath, in which provision may be made for automatically drawing the temper.

While the critical point in the heating of carbon steel does at all times indicate the degree of heat at which the steel may be quenched to the best advantage, it must be borne in mind that there will be a rapid drop in temperature of the heated steel during the time period required to transfer it from the heating furnace to the quenching bath; and in order to insure the steel being quenched at the critical point, it should be heated to approximately 100° F. higher before being removed from the furnace.

As the striking end of hollow drill steel for hammer drills is usually equipped with lugs or a collar to properly position the steel in the path of the piston hammer, it is desirable to subject the shank end, for a distance of from 2 to 2½ inches below the lugs or collar, to an oil treatment in order to provide for toughness and to make the angular section through which the rotary motion of the drill chuck is transmitted to the drill steel as wear-resisting as possible. To accomplish this, heat the shank slightly above the critical point, remove from the furnace and dip the tip end in a receptacle containing several pounds of cyanide of potassium, then plunge in oil, letting it remain in the oil until cold.

For holding the oil a quenching tank will be required equipped with a grate bottom placed two or three inches above the bottom of the tank. This will prevent the steel from coming in contact with dirt or sediment in the bottom and will serve to eliminate "soft-spot" trouble. A great many devices for quenching and drawing the temper of rock-drill bits automatically have been and are being used successfully, but a device similar to that adopted by the Homestake Gold Mining Co. is worthy of consideration for average mine and contract conditions. Fig. 18 shows a diagrammatic sketch of this apparatus.

This consists of a metal tank partly filled with running water in which is submerged a revolvable perforated disk set at an angle with respect to the surface of the water. From this disk a skeleton framework is provided for supporting and nonpositively locking the drill steel in position, which is disengaged by a stationary knock-off lever when the steel has been tempered for ser-

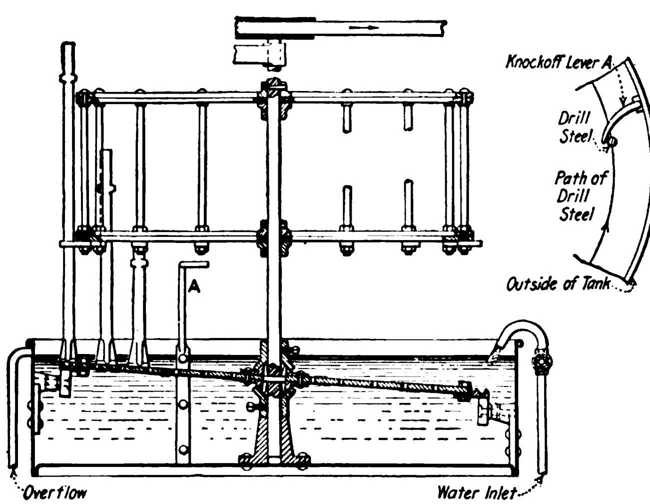


Fig. 18. The Homestake Quenching Tank for drill steel

vice. For hardening and tempering the drill bit, the steel is removed from the heating furnace when the critical point has been reached and the bit end is immediately quenched by placing it in a vertical position on the outer edge of the revolving disk and at the point which is nearest the surface of the water, it being locked in this position by a spring latch. This disk is made to revolve slowly and continuously, thus causing the drill bit to be submerged gradually in the bath (which is in a state of agitation) until it reaches the point diametrically opposite that at which it was positioned. Then it is gradually raised from the bath until it is automatically disengaged by the knock-off lever, it having traveled through approximately 315° of a circular path. A number of drill steels may be mounted on the disk, depending upon the number of vertical supports with which it is provided.

This method of quenching and tempering automatically possesses many advantages, chief among which is that it insures uniformity. The apparatus is flexible, and the maximum and minimum depth of submersion and the speed at which the disk revolves may be varied to suit the requirement. Owing to the gradual submersion of the bit, there is a blending from the hard to the untempered portion, which reduces to a minimum the liability of breakage.

INSPECTION OF DRILLS BEFORE LEAVING SHOP

It is excellent practice to inspect each drill steel subsequent to the tempering operation and prior to the transportation of the steel from the shop to the drills. It should be the duty of the inspector to see to it that each piece of steel comes within the permissible limits that may be established. He should make sure—

That the drill steel is straight and that the bit and shank are formed in alignment with the steel body;

That the shank is of the proper length and shape;

That the lugs or collar at the base of the shank are of the proper diameter and length;

That the hole throughout the steel is of the proper size and free from obstruction;

That the striking end of the shank is flat and square, with the inner and outer edges slightly rounded;

That the bit is of the proper shape, with the cutting and reaming edges formed full and to the required size;

That the gauge of the bit is of the correct size for the length of the steel;

That the reaming edges of the bit are concentric with the axis of the steel;

That the angle of the reaming side corresponds to the standard that may be established for the existing conditions;

That there are no sharp corners at the shoulder where the bit blends into the steel body;

That the drill steel is free from cracks and other imperfections which might result in breakage when put into service;

That the steels are of the proper length to correspond with the established length of steel change.

The object of the smithshop foreman should not be to see how many drill steels he can put through the forge or drill-sharpening machine, but to see how many correctly shaped, gauged, tempered and sorted drill steels he can turn out per unit of time.

For inspecting the shanks, a hollow gauge of the correct length with its inside diameter of such a size and shape that it may be readily passed over the shank body and lug is recommended.

For inspecting bits, a limit ring gauge about 1½ inches long for each size of bit may be used to advantage. The bore of the gauge should be slightly tapered in order that the larger diameter at one end may determine the maximum, and the smaller diameter of the other end the minimum permissible for each size of bit. The

method employed when inspecting is to place the large end of the gauge over the finished bit, which, if it enters but does not go through, will indicate that the gauge diameter of the bit is within the permissible limits. It will also determine if the reaming edges are correctly formed. For convenience the ring gauge may be made with a segment of its wall cut away, thus providing a means for the inspector to determine if the required clearance is provided at the rear of the reaming edge.

Remember that great importance is attached to having the drill bit true in every particular so that the shank is in a straight line with the axis of the steel and the outside edges of the bit are in a true circle.

188 "SULLIVANS" IN SERVICE

Since the last issue of MINE AND QUARRY, 75 additional men have left the organization of the Sullivan Machinery Company to join the colors. Notes regarding their activities follow:

R. S. Weiner is now attending the fourth engineer officers' training camp at Camp Lee, Petersburg, Va. Until May 5th he was attached to the field artillery, National Army, at Camp Funston, Kansas.

George W. Haskins, Huntington Office, has finished the prescribed course at Call Field, Wichita, Texas, and has been commissioned as second lieutenant, Signal R. C., as reserve military aviator. He is at present taking an advanced course in Aeronautical Engineering at Cambridge, Mass.

Captain M. R. Blish, Ordnance R. C. is now commanding officer, Saybrook Proving Ground, Saybrook, Conn.

Charles G. Miller is overseas with the 110th Engineers, Co. E.

Paul W. Glover was graduated from the Third Officers' Training Camp and at last accounts was enroute to France for further artillery training.

Members of the Sullivan Machinery Company's Diamond Contract Drilling Staff, who have recently entered the service are:

Martin Marley.
Walter Anderson.
Victor Carli.
Manford Spangler.

Daniel P. O'Rourke, Co. D, 23d Engineers (road builders) is overseas.

The Paris Office of the Sullivan Machinery Company will be glad to receive a visit from any Sullivan man in the army or navy. Mr. Rossback, Manager, writes:

"We mean not only former employes of the Sullivan Machinery Company, but all users of Sullivan equipment."

The address is Compagnie Sullivan, 18 Ave. Parmentier, XI^e.

Clifford Christiansen, coal cutter demonstrator, Chicago sales force, is in the navy, at Great Lakes, Ill.

Eugene M. Clare, Chicago order department, joined the National Army June 29.

Sergeant Harold L. Browne (Joplin) is an instructor in aeronautics in the Signal Corps school at St. Paul, Minn.

VOLUNTEERS, CHICAGO WORKS

Robert Armstrong, Canadian Infantry.
Charles Scott, Canadian Engineers Contingent.
Harvey Osterholm, Red Cross Ambulance Driver, Italy.
Edward R. Rakowski, Naval Training Station, Great Lakes.

NATIONAL ARMY ENLISTMENTS

Geo. Barker, Infantry.
Thomas L. Dean, Supply Co. 56th Infantry, Camp MacArthur, Texas.
F. Dvorak.
J. Schultz.

Second Lieutenant S. A. Benson, 122d Field Artillery, was at last report enroute overseas with his organization.

PVT. HUGH DURWARD, JR.
Ordnance Department,
Camp Hancock, Georgia

ROBERT ARMSTRONG
Canadian Royal Dragoons

CORP. HAROLD C. POTTER,
Co. G, 101st Amunition
Train, France

VICTOR S. LARSON
Co. B, 132d Inf., U. S. A.

LEO F. BRUNELLE,
U. S. Navy

CHARLES H. COFFIN
Q. M. Corps, France

HAROLD CLEVELAND
Corp., 77th F. A., France

CORP. J. L. AGEE
115th F. A., Camp Sevier

PVT. JOHN L. THAYER
54th Reg., Bat. D., C. A. C.,

Charles H. Coffin, Huntington Office, who has been at the Quartermasters' School at Camp Johnston, Florida, for several months, sailed early in June for duty overseas.

Sergeant Henry T. Richotte, (Claremont) who has been in France since last Autumn, was reported as slightly wounded in a casualty list published early in May. He was off duty only a few days.

R. E. Benedict, formerly of Spokane office, who enlisted as a private in the 27th engineers, arrived safely overseas early in March.

Ray A. Farnham, Diamond Drill foreman, is a private in Company D, 328th machine gun Company, Camp Custer, Michigan.

Charles Vance, Diamond Drill field staff, is attached to the 16th Company, Fourth Battery, 159th D. B., Camp Taylor, Ky.

W. Maurice Nichol, Toronto Office, has volunteered for the British Royal Air Force, at Toronto, and is studying for a commission as lieutenant.

Private Clifford H. Perkins, of the sales engineering course, (Claremont) is now attending the Sergeant Major's School of the Ordnance Department, at Washington, D. C.

Private Harold S. Flint (Claremont) is attending the Signal Corps School at the University of Vermont.

Wilfred Hart, originally reported in the U. S. Cavalry, is now in the Navy.

Henry C. O'Brien (Boston) has completed his course of study as a military aviator, and is overseas, attached to a bombing squadron.

More Claremont men overseas:

William Bonneau.
Raymond F. Cadair.
Leslie Cady, 1st American Exp. Force.
John Cockron (reported killed).
John Cook, 103d Reg.
A. T. Fontainer, Aviation.
W. Kelley, 103d Reg.
Sergeant Lacasse, 103d Inf.
Leon R. LeClair, 103d Inf.
Edward A. Riddle, Co. N. 103d Inf.
Harold Turner.
C. A. Weston, 103d Inf.

Eugene Kivett, Diamond Drill field staff, enlisted in the navy last fall, and is in the 68th Company, U. S. Naval Training Station, at Norfolk, Va. His brother, Henderson Kivett, was assigned last summer to Camp Gordon, Atlanta, Ga., for training.

William Jean Brown, until recently attached to the St. Louis Office, is now in the 154th Depot Brigade, at Camp Mead, Maryland, 5th Company, 2nd Battalion.

Carl P. Gorely, Claremont engineering department, is attached to headquarters staff, 101st Engineers, 26th Division, France.

The following men have enlisted from the Claremont works since the last report.

Arthur B. Allen, Jr. U. S. Navy.
John Amour, Tufts College, Mass.
R. W. Bates, Durham College, No. Car.
William Baker, Marine Corps.
John A. Baker, Naval Reserves, Mass.
Bartholamin, Location Unknown.
Albert Basslow, Canadian Army.
Corporal Ralph Berdell, 9th Co. Artillery.
Charley Bert, Aviation.
Stuart H. Brock, Location Unknown.
A. F. Butman, U. S. Navy.
E. E. Carney, Location Unknown.
Kent B. Casse, Location Unknown.
Lyle L. Craig, Signal Corps, Texas.
Ernest Curtiss, Camp Devens, Mass.
Walter Curtiss, Camp Devens, Mass.
T. J. Defasses, Texas.
Deoss, U. S. Navy.
Arthur Facier, Fort Slocum, N. H.
William J. Fluette, Naval Aviation Band.
Max V. Gale, Merchant Marine.
Joe Giguire, Durham College, No. Car.
Goodroe, Location Unknown.
E. F. Griffith, Ordnance.
Hazelton, Merchant Marine.
Oten Johnson, Camp Devens, Mass.
Kimball, Location Unknown.
Knights, Signal Corps, Florida.
F. G. Langmaid, Durham College, No. Car.
Arnable Laplume, Fort Slocum, N. H.
P. H. Lawrence, Signal Corps.
Leshkovich, Camp Devens, Mass.
Anthony Lizotte, Aviation, Texas.
Joe Mallzic, Italian Army.
Marshall, Machine Repair Shop, Texas.
Carl Martin, Camp Devens, Mass.
Joe Mazyino, Camp Devens, Mass.
McKerty, Regular Army
Von J. McPherson, Ordnance Dep't. Maryland.
George E. Montgomery, Fort Slocum, N. H.
Thomas Morton, Location Unknown.
William Murphy, Location Unknown.
Osgood, Canadian Army.
Walter Perry, U. S. Navy.
William A. Racine, Durham College, No. Car.
Arthur Seymour, Location Unknown.
Ernest Seymour, Florida.
Frank Skinner, Durham College, No. Car.
Earl Willard, Tufts College, Mass.

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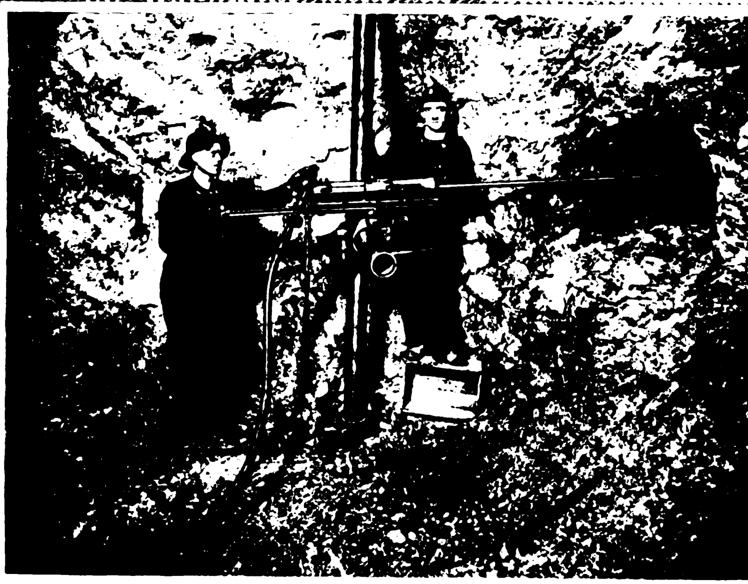
Mine and Quarry, July, 1918

MINE AND QVARRY

REG. U. S. PAT. OFF.

VOL. XI, No. 1 NOVEMBER, 1918 WHOLE No. 36



Sullivan "DR-6" Water Jet Drifter in a Zinc Mine, Joplin District, Missouri.

AN IDEAL SHARPENER SHOP
SINKING THE SENECA SHAFT
MORE POWER FROM NIAGARA

PVBLISHED BY THE SVLLIVAN MACHINERY CO. 122 S MICHIGAN AVE., CHICAGO

TABLE OF CONTENTS

MINE AND QUARRY

REG. U. S. PAT. OFF.

VOL. XI, No. 1 NOVEMBER, 1918 WHOLE No. 36

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address.

The War is over. Germany and her allies are defeated. The world is ready to rebuild and repair the wastes of war. An era of activity is in sight for mines, quarries, contractors and manufacturers, particularly in America, beyond anything in our history.

As a new year opens, let us give thanks that our efforts and sacrifices have accomplished their purpose; and let us resolve to do our part as citizens of this country, with a new pride and a new feeling of responsibility.

Mine and Quarry regrets to announce the death, on October 21, of Mr. Lee A. Knights, for 16 years a member of the engineering staff of the Sullivan Machinery Company at its Claremont, N. H. Works. For the past nine years, Mr. Knights had specialized in rock drills and hammer drills, as assistant to the chief engineer of that department, Mr. George H. Gilman. He was chief instructor in the company's free evening drawing school. Mr. Knights took an active part in winning the war at home, serving on the legal advisory committee of the draft board, on the Claremont committee of public safety, as a director of the "Four Minute" speakers, and as an active member of the Claremont rifle club. His paper in this issue, written several months before his death, on "How Large an Air Compressor Shall I Buy," constitutes a contribution of value for all users of air power.

The article by GEORGE H. GILMAN in this issue on an "Ideal Shop for Sharpening Drill Steel," should appeal to quarry owners and contractors, as well as to mining men. We cannot do better than reprint an Editorial from the *Engineering and Mining Journal* in whose columns the paper first appeared.

"The article will not only be of exceptional interest but also of specific adaptable value to all mine operators in connection with their problems of reducing the cost of machine-drill expense per ton of production. Mr. Gilman, as an engineer of wide experience in the field of machine drills and machine drilling, has given us an authoritative presentation of an important subject, the outcome of long study and extensive research at the mine and in the factory. The best in labor-saving equipment that could be found in actual use throughout the mining districts of the country has been collected, remodeled where advantageous, designed where missing or insufficient and then classified, grouped and arranged into one practical standard workshop designed to do one thing — that thing being the collecting, sorting, cutting, forging, gaging, tempering, inspection and redistribution of rock-drill steel so as to yield the best there is in drill bits and shanks on the greatest possible scale with the minimum amount of labor and time. Every progressive mine manager must recognize the value of Mr. Gilman's contribution to his needs, its excellence and its value in practical adaptability to his conditions. A standard has been set for "doing our bit" at the mines. This paper should be given serious attention by every mining engineer in the country."

Sullivan Rotator Shaft Crew at the Seneca Mine, Mohawk, Mich.

SHAFT SINKING AT THE SENECA MINE

By W. V. Featherly*

[The information from which this article was made up was furnished by Mr. J. M. Broan, Superintendent in direct charge of the shaft sinking work. The header or hanger shown in the illustration was designed by Mr. Broan and the organization which secured the excellent results described below was planned and carried through by him. The use of a hanger for supplying air to the drills and handling them in the shaft was first used by Mr. Broan when sinking the Woodbury Shaft of the Newport Mining Company at Ironwood, with which he was connected at that time. Mr. Broan contributed an article to Mine and Quarry for January, 1916, in which this shaft was described. It will be recalled that a record of 201 feet for a single month's sinking was made on that shaft (also with Sullivan Rotators), and that over 2100 feet of shaft were sunk in a year's time. The author's thanks are due Mr. Broan for his assistance in preparing the present article.]

The Seneca Mining Co., at Mohawk, Mich., is sinking a compound shaft, which is to be vertical to a point 1450 ft. from the surface and will then follow a 400-ft. radius curve to meet the Kearsarge lode, which dips at an angle of 34° from the horizontal. The equipment and methods adopted in sinking are in accordance with modern practice, and the progress made has established a record for shaft sinking in the Lake Superior district.

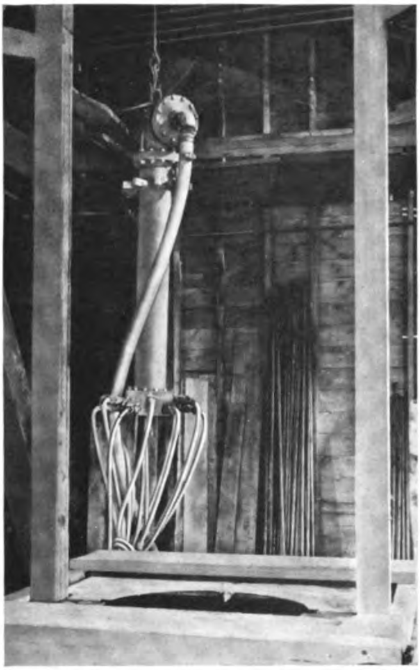
The shaft is to be of four compartments, having two skipways, one ladderway and one pipe compartment. Over-all dimensions of the excavation are 11 ft. 4 in. x 21 ft. 4 in. and steel sets of 5-in. H-beam construction are placed at from 6 to 8-ft. centers, depending upon the nature of the ground. These sets are put in so that they are placed 4 ft. from the bottom when the ground is soft, up to 30 ft. from the bottom when the ground is hard. The lagging is of 2-in. hard wood.

A double-drum steam hoist operates two 36-cu. ft. buckets. Air is furnished by one Sullivan tandem-compound, Corliss steam-driven compressor, and one class WB-2 Sullivan straight line, simple steam, two-stage air compressor is installed as a reserve. At the beginning of operations eight Sullivan DP-33 air tube rotators and eight hand hammer-drills of another make were in use. It was soon obvious that the Sullivan Rotators were securing better results. Four more Sullivan Rotators were purchased in April, and since that time 11 have been in constant operation, and two kept as spares. The header, shown in an accompanying cut, is connected to the main air line by a 3-in. hose and is supported in the center of the shaft while drilling by means of a cable leading from the steel framework. There are 11 hose lines, each 14 ft. long and leading from the bottom of the header to the drills; also one connection for a blow-pipe.

EARLY PROGRESS MADE UNDER HANDICAPS

Excavation was begun on Feb. 13 during severe winter conditions as well as other handicaps. Water froze in the buckets, there were no steam lines installed in the shafthouse, and the rock had to be trammed by hand. Three shifts were worked, with only four or five men on a shift, and under these conditions progress was slow. During February, 51 ft. was sunk, and in March 113 ft., with conditions about the same. Early in April the rock-disposal haulage outfit was completed, the headframe inclosed, and steam heating coils were installed, so that 154 ft. of shaft was sunk during that month. By increasing wages 50c per day the management was able to secure sufficient men by May 1, and since that time the work has been carried on at full capacity,

* Walker Bank Building, Salt Lake City, Utah.



Drill Hanger or Header, Seneca Shaft

the crew averaging ten men and one shift-boss per shift, and working three shifts.

During May 208 ft. was sunk in 27 working days, and this rate was maintained in June, when 195 ft. was sunk in 25 working days. This figure would have been exceeded had not the men encountered loose, soft ground, which caused considerable delay, as it was necessary to keep the steel work close to the bottom of the shaft to guard against loose rock falling on the men.

The bonus system which has been adopted consists of the following: The men receive a flat rate per day up to the first 100 ft. per month; 2c per foot per day for all over 100 ft. up to 150 ft. per month; 3c per foot per day for all over 150 ft. up to 200 ft. per month, and 4c per foot per day for all over 200 ft. per month. This provides an incentive for the men to work hard, and each shift tries to send up more rock than the previous one. The shifts are well organized, and the same men have their regular work to do each time they blast. Two men attend to the raising and lowering of the header, which is hooked on the bottom of one bucket. The drills are taken up in the other bucket. One man looks after the main wires while the others are charging the holes and getting the tools up. The last two men connect the main wires. One of them inspects everything at the last minute and carries the key to the blasting switch.

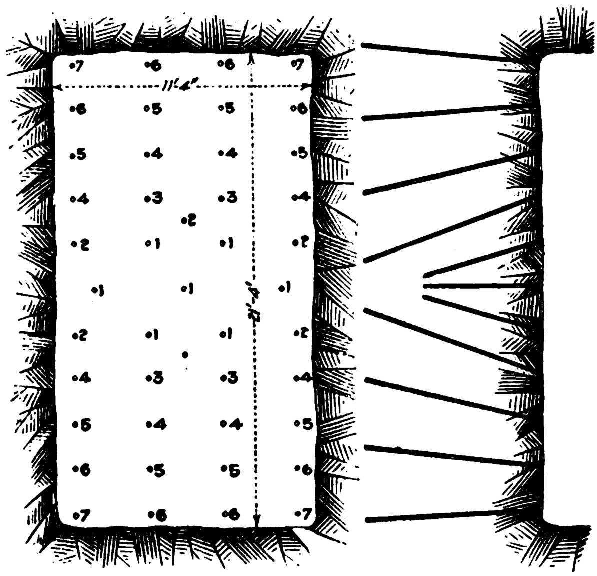
METHOD OF CHARGING AND BLASTING

In blasting, electric igniters and blasting caps are used. The bottom of the deeper holes is charged with 60% powder, 45% being used in the remainder. The average depth of hole is 8 ft., and the round of 45 holes is drilled in from three to five hours. The "sink" is made with a double V-cut, and is shot in two separate blasts, the cut holes being fired first. In the diagram, cut holes numbered 1, 2, 3, and 4, are shot in that respective order with instantaneous and delay caps. If all of these holes break satisfactorily, the squaring holes numbered 5, 6, and 7 are set off. This plan insures the breaking of the sink holes before the ends of the shaft are squared. Thus far, two pounds of explosive per cubic yard of rock has been the average.

Eight construction men are employed in placing sets while the men are drilling and not using the buckets. In drilling, ⅞-in. hollow drill steel is used, and this is sharpened and shanked by machine.

Ventilation is secured by means of a 7½ hp. blower, which forces fresh air through a 16-inch Flexoid tube. With this equipment it is possible to return to the bottom of the shaft in less than ten minutes after blasting. Light is furnished at the bottom of the shaft by two factory domes, with four 100-watt lamps in each dome. The men are required to wear special hard hats, made of felt,

treated with resin and shellac, which will resist a severe blow. Movable sollars, made of steel plates and operated by levers, are placed over the two compartments used for loading supplies in buckets. When the bucket hangs at the brace, the lever is thrown and the plates close in around the bucket, making practically a complete cover over the compartment. Electric signals are employed throughout.



Shaft Drilling Round, Seneca Mine

On Sept. 30th the Seneca Shaft was 1312 feet deep. The progress by month had been as follows:

May	208 ft.	(27 working days)
June	195 ft.	(25 working days)
July	202 ft.	(26 working days)
August	205 ft.	(27 working days)
September	184 ft.	(24 working days)

A later report states that the shaft has reached a depth of 1600 feet, and that the record-breaking speed continues.

(*Engineering and Mining Journal*)

SULLIVAN AIR-LIFT SOLVES PUMPING PROBLEM AT GALESBURG

By John Oliphant*

The city of Galesburg, Ill., has had considerable difficulty in securing sufficient water for the public supply. A number of wells in the neighborhood of the old pumping plant have been driven and equipped with various devices, but failed to give the amount of water needed. The old plant consists of three deep and six shallow wells, with a combined yield of about 250 gals. per minute, and has been very expensive to operate and maintain.

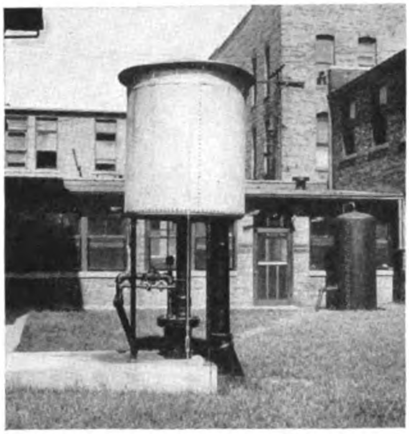
Under the present city administration the question of drilling a well at some distance from the old plant was taken up, under the direction of C. W. Whitney, and the Whitney Well Company was employed to drive a well to a depth of 1,250 ft. A strong flow of water was developed.

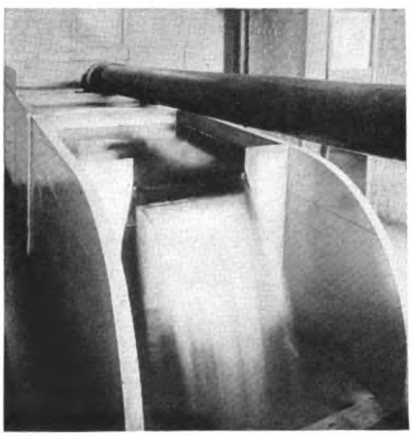
THE NEW WELL

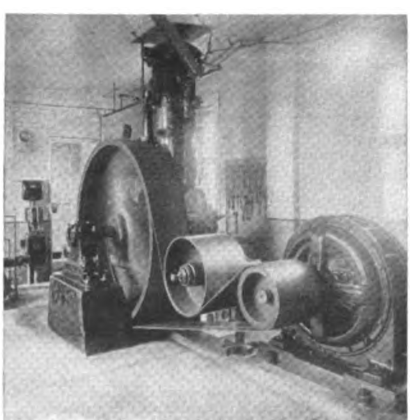
The construction of this well was as follows: 40 ft. of 24-in. heavy steel cas ng; 106 ft. of 20-in.; 130 ft. of 16-in., and 350 ft. of 12-in. steel casing. The 12-in. is sealed in the rock. The hole was then drilled 12 ins. in diameter to a depth of 1,085 ft. from the surface, then reduced to 10 ins. and drilled down to 1,255 ft. through the St. Peter's sandstone formation.

The well was then shot with two 200-lb. charges of 100 per cent gelatin, covering the entire sand rock strata, and carefully cleaned out.

*Chief Engineer, Pneumatic Pumping Department, Sullivan Machinery Co., Chicago.







Genuine wrought iron 10-in. pipe was installed and sealed into the top of the 12-in. pipe, approximately 350 ft. from the surface of the ground. This extends to within 3 ft. of the top of the sandstone strata, hermetically sealing the well from all water in the strata above the St. Peter's sandstone. The analysis made from the water secured from the completed well was superior to that of all other wells in the territory, on account of the sealing off of the upper strata.

At the site of this well an auxiliary plant was constructed, lifting the water from the well to a small surface reservoir by means of the air lift. Thence the water is forced into the mains against 40 lbs. pressure with a centrifugal pump.

AIR-LIFT EQUIPMENT

The air-lift equipment consists of one Sullivan angle-compound, Class "WJ-3" compressor, with 16x9¾x12-in. cylinders, arranged with short belt drive and unloading valve; one Sullivan standard 5-in. foot-piece (outside air line), and well-head with umbrella separator complete; one 42-in. x 8-ft. vertical steel air receiver, and one 100-h.p. General Electric motor.

A float regulator was installed so that the water level in the receiving basin controls the amount of air delivered to the lift by unloading the compressor and regulating the water delivered to the centrifugal pump, which, in turn, is controlled through an electric governor by the city pressure, making the plant automatic throughout.

CONDITIONS OF OPERATION AND RESULTS OF TEST

The following are the conditions of operation and the results of the test on the well:

Views of New Air Lift Pumping Equipment at Galesburg, Ill.

Top: Well and collector head in center of group of municipal buildings, air receiver at the right outside engine room. Center: Discharge into weir box over concrete storage basin. Foot: Air compressor short-belt connected to electric motor.

Number of wells	1
Depth	1,252 ft.
Water pipe in well	235 ft. 3 ins. of 5-in. 330 ft. 9 ins. of 6-in.
Main air pipe in well	235 ft. of 2-in. 331 ft. of 2½ in.

On account of the severe drop an auxiliary starting device was installed at a depth of 481 ft. 8 ins., to pump off the head and keep below excessive starting pressure.

Static head (from ground)	186 ft.
Drop	118 ft.
Elevation above surface	7 ft.
Total lift	311 ft.
Operating submergence	262 ft.
Percentage of submergence	45.8
Depth of pump in well	566 ft.
Operating pressure	121 lbs.
Starting pressure with auxiliary	129 lbs.
Gallons per minute pumped	450
Actual cubic feet of free air used	450
Revolutions of compressor	179
Water horse power, that is, ft. lbs. of work done	35.5
Operating horse power	94
Efficiency per cent	37½

HIGH EFFICIENCY SECURED

The percentage of efficiency shown is considered excellent, and this result was made possible by careful proportioning of the sizes of air and water piping, proper location of the foot-piece or pump in the well, and by the use of the improved Sullivan foot-pieces, providing a continuous flow of water. In this design the air is discharged from the foot-piece into the water, in the well casing, in a multitude of fine jets, creating a very thorough mixture or emulsion of air and water. This action secures the maximum efficiency, as the chance of slippage is reduced to the minimum.

The accompanying views, taken at Galesburg, for this purpose, illustrate the new water station.

First is shown the location of the well in a court yard, in the center of the group of municipal buildings. The building at the left is the City Hall, and at the right is the rear of the fire station. The air compressor and pump are in the one-story engine room in the background. In the foreground is the well and collector head, in which the water stands about two-thirds full. The water is discharged in the large pipe at the right and is carried by gravity to the engine room. The air receiver is shown outside the building at the right.

In the center is the water discharge pipe, coming into the weir box in the engine room. Over this weir the water is measured before falling into the concrete storage basin or cistern.

At the foot is shown the Sullivan angle compound air compressor, short belt connected to an electric motor. The vertical cylinder and a portion of the intercooler of the compressor may be seen, the low-pressure or horizontal cylinder being obscured by the flywheel.

Mr. J. W. Thompson is chairman of the Galesburg Water Committee. — *Municipal and County Engineering.*

LIBERTY LOAN OVERSUBSCRIBED

The employes of the Sullivan Machinery Company at the Chicago Works organized a Liberty Loan Campaign Committee of their own and turned over a subscription for the Fourth Loan greatly in excess of that secured for the third loan. Every employe subscribed, and a large percentage took "plus" subscriptions. An equally creditable record was made by the factory and engineering forces at Claremont.

Chicago Works Employes of Sullivan Machinery Company Organizing Their Armistice Day Parade, November 11.

USE OF THE CEMENT GUN IN A BITUMINOUS COAL MINE

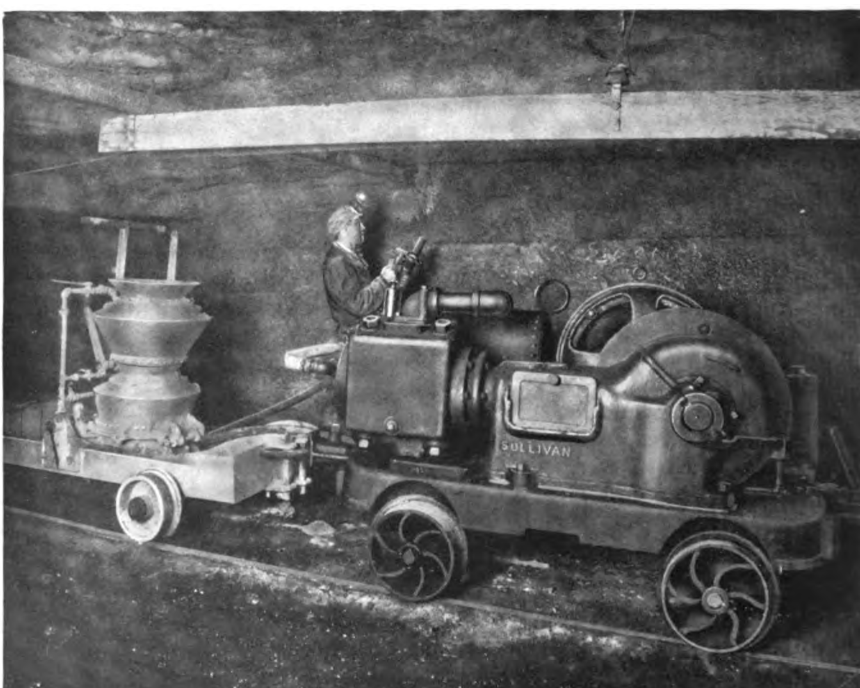
By M. S. Sloman*

Numerous experiments have been made and exhaustive tests conducted by the Bureau of Mines and various coal companies in the bituminous fields on the application of a cement coating on roofs and ribs to prevent weathering and the costly falls of rock due to this cause. While considerable work has been done in this direction, the results obtained have, until recently, been considered of rather questionable value by some who have been waiting to see the condition of the coating after it had been applied for a considerable length of time.

The United Coal Corporation, of Pittsburgh, Pa., with several large operations, was one of the first to become interested in this subject, and the results obtained by them seem to prove conclusively that a cement coating, properly applied, will form a permanent barrier to the action of weathering on roofs susceptible to air slacking.

The work has been carried on at their Edna No. 1 mine, located at Adamsburg, Westmoreland County, Pa., near Pittsburgh, where they are working the Pittsburgh seam, averaging six feet in thickness, with the characteristic roof coal of about twelve inches and above that a slate and clay composition containing limestone which is readily disintegrated by contact with air. Without question

*Farmers' Bank Bldg., Pittsburgh



Cement-coated Roof and Ribs in Main Slope at United Coal Company's Edna No. 1 Mine. Cement Gun and Sullivan Air Compressor Outfit in Foreground

this cement gun coating was applied under the most adverse conditions that could be found. The coal is taken from the mine through a main slope, first started some 18 years ago, and driven in 6500 feet. Trouble has been encountered from the start due to falls from roof, as evidenced by the average distance from the coal to the roof, which is about 12 feet — frequently the road was completely blocked by such falls, necessitating the closing of the mine on an average of three or four days every summer. Owing to the risk involved, no man-trip could be run and the miners were obliged to walk in and out from work. It was on this slope where the work was started on November 1st, 1917.

The equipment consisted of an "N-1" Cement Gun, manufactured by the Cement Gun Company, Inc., Allentown, Pa. Essentially it consists of a hopper with control valves for mixing the material and a nozzle at the end of a hose, where the dry sand and cement, conducted under air pressure, is mixed with water and directed at high velocity on to the surface to be coated. This apparatus is mounted on wheels of suitable track gauge, making it entirely portable.

In this mine, as in many others electrically equipped, there is no supply of compressed air available. To meet demands of this nature, the Sullivan electrically operated portable air compressor was developed. This can be conveniently taken into the mine to the location of the work. It consists of a single stage compressor driven by a motor through gearing, all mounted with an air receiver on a substantial base which in turn, with addition of wheels and axles, forms a truck, making the entire outfit compact, of the smallest possible over-all dimensions and strictly portable.

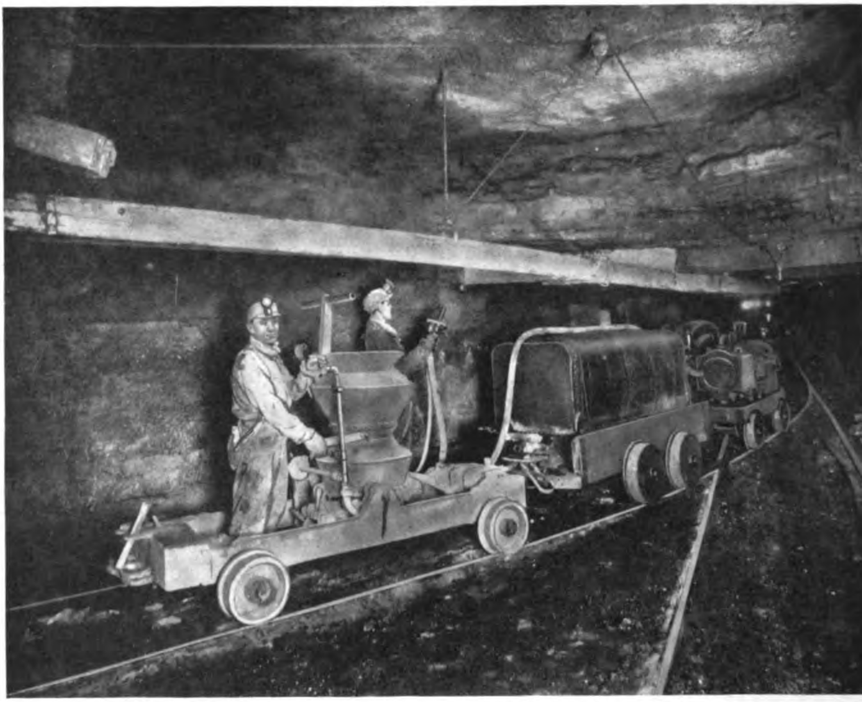
For this service, as well as for other considerations, the size "WK-2" 10 x 10, 35 h.p. outfit is considered standard. So many other valuable uses have been found for this compressor outfit that it is now standard equipment in many mines. For example, it is being used to great advantage in connection with the operation of Sullivan DP-33 "Rotator" Hammer Drills for all rock work, and in some places to operate two or more pneumatic coal punchers in advance heading work. It is often taken outside, where the compressed air is used for many purposes, such as in cleaning out motors or electrical equipment, to drive a chipping hammer, drill or other industrial tools.

Since there was no supply of water under pressure available for this use at the Edna mine, an ingenious system was used. A large tank, of size to hold sufficient water for a shift, was mounted on a mine car; a connection was made with the air receiver and this water, brought under air pressure, was forced up to the spraying nozzle.

APPLYING THE "GUNITE"

The work is done at night by a crew consisting of from five to eight men. One man operates the gun, one the compressor, who serves as general mechanic; two others mix the material and one operates the nozzle; in addition, the following men are employed outside for part of their time: One hauls material, one dries sand and one handles the hoisting rope when working on the grades. It was found that the mixing could best be done outside the hopper, so wooden boxes are used for that purpose and the mix dumped into the hopper. The mix consists of three parts fine sand (and this must be thoroughly dry) to one part Portland cement. The air pressure for the most effective work should be from 40 to 60 pounds, while the water should be under a pressure of about 20 pounds, higher if possible.

The surface to be coated is first thoroughly cleaned and scaled, which is most essential. It is the opinion of Mr. Maize, the local superintendent, that where pos-



Cement Gun, Water Tank and Sullivan Air Compressor Outfit, United Coal Company, Showing Roof and Ribs Coated with Gunite.

sible, the use of a stream of water would prove very effective. No wire or reinforcement of any kind is used in coating the bare roof and side walls, and the coating is applied direct, averaging one-half inch in thickness.

Pieces of coating afterward broken off show a perfect bond existing between the cement and the substance composing the surface, whether it be coal or rock. In coating the timbers, a one-half inch wire mesh is first stretched and secured to the surface before the cement is applied.

An accurate record of progress and costs has been kept from the start and these figures will no doubt prove interesting. The total cost of coating 6250 feet of slope, averaging 12 feet in width and 12 feet in height on sides has been $7488.58. This figures a net cost of 30c per square yard.

The following figures taken at random show detailed costs on a length of 900 feet of slope which was completed in 13½ shifts of 8 hours each.

1 mechanic	$ 71.85
1 engineer for rope hoist	65.48
1 operator Cement Gun	71.85
2 mixers at $63.45	126.90
1 man at nozzle	63.45
1 man drying sand	61.40
1 man haul material part time	23.50
540 sacks cement at 60 cents	324.00
1620 sacks sand at 12 cents	194.40
Total	$1002.83

This section figured about 36 square feet per foot of advance, making the actual cost on this work 27c per square yard of surface coated. This cost, as will be noted, included the outside engineer, which charge would not be necessary in

most cases. It is interesting to note the progress made, which approximated 90 square yards per shift of 8 hours.

In addition to the main slope, the entries and break-throughs are coated. The "gun" has also been used with success in making stoppings air tight and in building up permanent stoppings.

This can be done by building up a wall of loose rock and then applying a thick coating of cement. An excellent air-tight stopping is the result.

It would seem that the coating has stood a sufficient length of time on the slope to enable one to judge as to its permanence. A large part of the coating has withstood the rigors of the coldest winter yet experienced, and the heat of an extremely warm summer. It is today in excellent condition and looks as strong and unbroken as when first applied. In a few exceptional cases only and that confined to small areas, has any spalling of the coating occurred. This was attributed entirely to improper cleaning of the wall before the coating was applied.

The beneficial results obtained at this mine have been such as to more than offset already the initial cost of the equipment and the cost of the work. Not a single fall of roof has taken place in sections coated, and, consequently, there has been no forced closing of the mine as was previously the case. This saving alone can be computed in dollars and cents. A regular man-trip is now run in and out of the mine and the saving of the long walk on the part of the miners has done much to make them more contented and efficient during the present tense times of maximum production.

Credit for the success of this work should be given to the efforts of an efficient crew under the supervision of the local superintendent, Mr. Joseph Maize, and the general superintendent of operations, Mr. E. H. Coxe. They both early foresaw the far-reaching benefits that could be derived if the work proved a success and great credit is due them as the leading successful pioneers in the use of the cement gun in the bituminous coal fields. Mr. Coxe is very enthusiastic over the results and expects to install similar equipment at an early date in the other mines of the company. The many mining men who have examined this work have pronounced it a great success and see a widely extended use made of the cement gun throughout the coal fields where trouble is experienced with bad roofs.

STEAM ROTATOR DRILLS DEEP HOLES

By W. V. Featherly*

The use of hand-feed hammer drills when operated by steam has seldom been attended by success for holes of more than about four feet in depth.

These drills have been used in the same way as machines operated by air, the steam passing down through the hollow steel to blow the cuttings from the holes. When the depth of hole reaches three feet, however, the cuttings have a tendency to bake and cling to the steel, and, as the hole grows deeper, this trouble becomes more pronounced, cutting down the drilling speed of the machine and requiring the frequent removal of the steel from the hole to clean out the cuttings.

The White Marble Lime Company, whose headquarters are at Manistique, Michigan, is now quarrying 150 tons of dense dolomite per day at its quarry located at Marblehead, Michigan, and is drilling the rock for blasting with one Sullivan "DP-33" Special Steam Rotator. The ledge method of quarrying is used,

(Continued on page 1097)

* Walker Bank Bldg., Salt Lake City.

THE OLD MINER

By Berton Braley

(In Engineering and Mining Journal)

I'm a bit too old for fightin', but when
  workin' on my shift,
As my noisy drill is bitin' at the ore seam
  in the drift,
I feel kind of like a soldier, and it seems
  this shakin' drill
Is a trusty young machine gun that is
  shootin' with a will;
And I sight along its piston like a gunner
  in the line,
And I guess it sort of thrills me when I run
  this drill of mine;
For it's makin' holes for powder that will
  shoot the copper free
To be used to make munitions
  for the cause of Liberty.

I would like to shoot a Lewis or
  a Browning gun in France,
But I'm dim-eyed and rheu-
  matic, and I'll never have
  the chance.
Yet I find some consolation
  when I fancy this machine
Is a snappy new machine gun
  that is drillin' Teutons clean;
I can think I'm right in battle
  as I hear its ringin' bark
And imagine every bullet that
  I'm sendin' hits the mark.

And although that's all a vision, and it
  goes and leaves me flat,
I can still feel like a soldier as the drill
  sings, "Rat-a-tat!"
For I'm minin' the material that goes to
  feed the guns
With shells an' rifle cartridges to land
  among the Huns;
So I'll call myself a fighter while the air
  drills bark and drum,
For I'm helpin' send the Kaiser and his
  gang to Kingdom Come!

HE DID! Now he can help civilization just as much by sticking to his drill while the allies repair the waste that the Hun's war has caused. — (*Editor*).

and holes 10 to 12 feet in depth are required.

This special steam Rotator is equipped with a water tube which enters the shank end of the hollow drill steel for about one inch. The steam to operate this Rotator is furnished by a small, vertical, portable boiler, with an 18-gallon water tank mounted thereon. This tank is of the kind used in connection with standard Sullivan "DR-6" Hammer Drills and with air driven, water tube Rotators. A short length of ½-inch hose is led from the boiler to the top of this tank, putting pressure on the water. A small quantity of steam condenses, of course, but not an appreciable amount. A 50-foot length of ¾-inch steam hose is led from the boiler to the Rotator, and a 50-foot length of ½-inch water hose from the water tank to the drill. This forces water through the water tube of the machine, and thence through the hollow drill steel, to clean the cuttings from the hole.

A valve on the water hose near the drill regulates the amount of water used for cleaning the hole.

An asbestos covering is laced about the handle of the Rotator to protect the operator's hands from the heat. A short curved exhaust pipe directs the exhaust steam away from the operator. The machine is otherwise steam tight, making it easy to operate.

An average of eight holes, or eighty feet, is drilled per shift. When the drilling is finished for the day, the portable boiler is hauled away a few yards, so that it will not be damaged by blasting. The rock is loaded in three-ton cars by hand and is hauled to the lime plant by a gasoline locomotive.

The work done by the Sullivan "Steam-Water" Rotator has proven so satisfactory at this plant that a duplicate outfit has been installed at another of the White Marble Lime Company's quarries.

CANADA BUILDS 300,000 H. P. NIAGARA HYDRO PLANT

By Louis B. Black, M. E.*

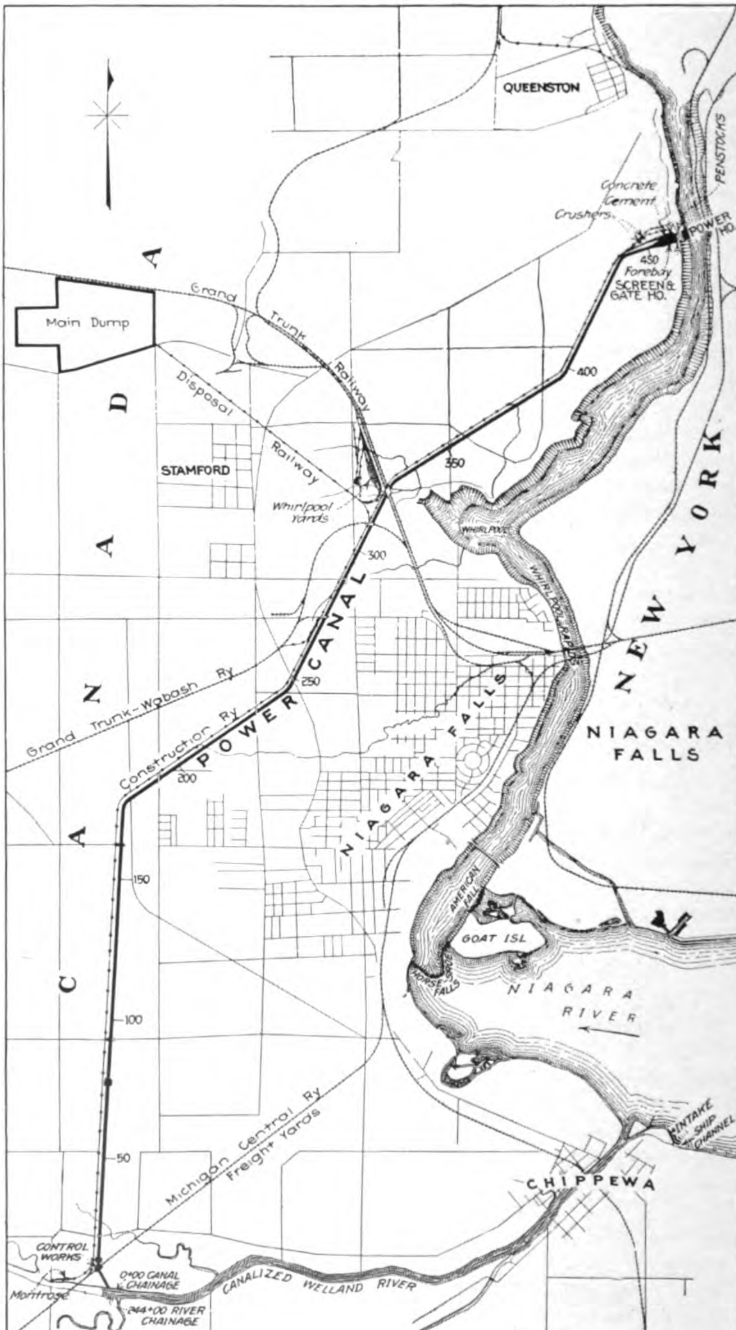
As early as 1914, the Hydro Electric Power Commission of Ontario foresaw a serious shortage of power for industrial and war purposes. This shortage has proved a great hindrance to increased output of ships and munitions. The commission is now engaged upon the construction of a canal eight and one-half miles long, which will divert a flow of 10,000 second feet of water from Niagara Falls, and enable 300,000 H. P. to be developed. This is the largest civil engineering enterprise now in progress in either Canada or the United States. Its estimated cost is $25,000,000 and, although begun in 1917, it will not be complete until 1921 or 1922, despite the fact that work is being carried on day and night.

*37 Colborne St., Toronto, Ont.

PLAN OF THE WORK

The general scheme, which is indicated by the accompanying plan, calls for an intake at the mouth of the Welland River, where that stream joins the Niagara River at Chippewa; reversing the flow of the Welland to a point 4¼ miles from its mouth; a canal roughly paralleling the course of the Niagara River to the north and northeast, from the Welland River to a forebay and power house on the Niagara, about two thirds of the distance from the Whirlpool to Queenston. This canal passes to the west of the town of Niagara Falls, Ontario.

The gross head will be 316 feet, and the net head 305 feet. Thirty horsepower per second foot will be developed, as compared with 14 H. P. per second foot from



Canal from Welland River to Niagara Gorge below rapids (Eng. News Record)

plants now operating. The power house, containing six 52,500 H. P. units, will be at the bottom of the gorge, just below the last rapids. The cliffs here are vertical so that the gate house can be placed only 200 feet or so from the gorge. The penstocks will be 13½ feet in diameter, and about 450 feet long, on a sharp angle, thus reducing cost and avoiding the use of surge tanks.

The canal gradient is planned for 1.1 feet per mile, which will give an estimated velocity of six to seven feet per second. The cut is 162 feet wide in earth, with slopes of 1½ to 1; and 48 feet wide in the rock sections, with vertical sides, the overburden being sloped 1½ to 1. The water will flow to a depth of 35 feet in the rock portions of the channel, and will wet the earth section to a vertical depth of about 26 feet, with a mean water line width of 84 feet. The bottom of the canal will be 34.6 feet wide in earth. From Montrose, where the canal leaves the Welland River, the first 8000 feet are in earth. The remainder of the canal is in rock, except for a section near the Whirlpool, which is in earth for about 2000 feet. The total amount of earth to be excavated is 11,000,000 cubic yards, and of rock, 4,000,000 yards.

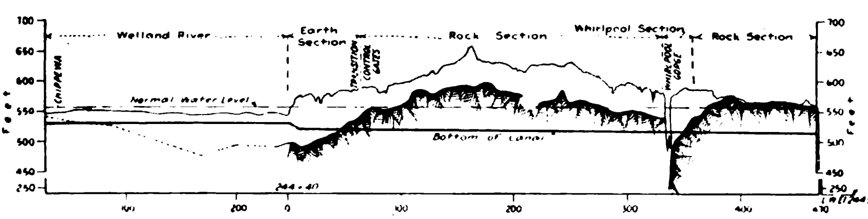
The Hydro Electric Power Commission has acquired a wide right-of-way for this work, with sufficient room to build two additional canals. It is stated that maximum efficiency could be gained by combining all the American and Canadian power appropriations from Niagara in one large plant on this site.

Preliminary surveys for this enterprise were made as early as 1914, and diamond drill borings were employed along the proposed line to determine accurately the nature of the rock formation. It was not until early in 1917, however, that actual construction was begun. The work is being performed by forces of the commission on its own account, and has been pushed with great vigor during the war. No diminution of effort has resulted with the conclusion of hostilities, as it is felt that the industrial development of this section of Ontario depends on the additional power which this undertaking will provide.

EARTH REMOVAL—HEAVY EQUIPMENT

The work of construction is proceeding on the river section and on the three land or canal sections simultaneously. In the river, 2,000,000 yards of earth are being removed by means of a Lidgerwood cableway, operating a three-yard clamshell bucket, and by a three-yard dipper dredge. The cableway has a span of 800 feet, with a head tower 80 feet high and a 60-foot tail tower. The dredge is handling 4400 feet nearest the Niagara river, loading the material on scows which are hauled out into deep water in that stream. The river cut is 40 feet wide and will be 30 feet deep.

Due to the accessibility and low cost to the Commission of electricity, this form of power is being employed for all possible purposes. Electric shovels are employed for excavation, and twelve



Profile Showing Different Sections of Canal and Materials Encountered in Each (Eng. News Record)

Niagara Power Canal at Station 443, Looking West. Taken Nov. 14, 1918. Note wall cut by Sullivan Channelers; also electric shovel and electric locomotive

Sullivan Channelers on the first cut at Station 316+25.5, Niagara Power Canal, October, 1918. Note the Heavy Overburden

50-ton electric locomotives were designed and built especially for this work. These receive their power from an overhead trolley, carried seven feet from the center of the track by portable supports, so as to provide clearance for shovels, cranes, etc.

HUGE ELECTRIC SHOVELS

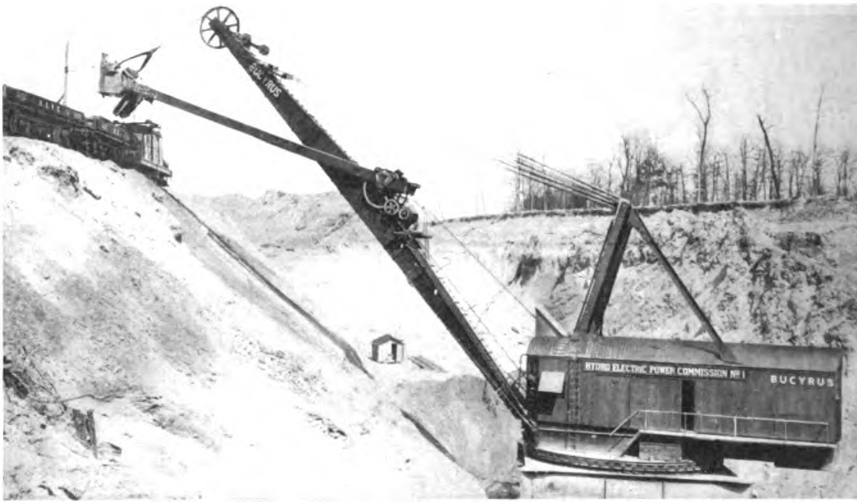
Due to the depth of the cut, ranging from 50 to 145 feet (at one point) and the prevalence of quicksand, the use of large, powerful excavators, capable of handling the work on a single lift was decided on. Perhaps the most impressive machines on the job are the three huge Bucyrus electric shovels, type "225-B." These weigh 375 tons each, develop 800 H. P., and are equipped with 90-foot booms and eight-yard dippers. The motors are Westinghouse type M.A., 440-volt A.C., 25 cycle, with Cutler-Hammer control. Transformers, mounted on the shovels, receive line current at 4000 volts and step it down to working tension.

The picture on page 1102 shows one of these huge shovels, which is removing 85,000 cubic yards of earth per month, loading cars at an average height of 86 feet above the shovel rails and working one ten-hour shift and no Sundays. Where the earthwork is completed, the eight-yard dippers will be replaced with five-yard dippers for handling rock. Three other electric shovels are in use of the Bucyrus 103-C, 110-ton pattern, developing 350 H. P. and having 4½ yard dippers and special booms for 19½ feet loading in the clear. These are all built of steel throughout. There are numerous other shovels and excavators, some operated by steam and others by electricity.

ROCK REMOVAL—CHANNELING

The rock encountered is Niagara limestone, and is overlain with fine drift ranging from 0 at the lower end to 40 feet in depth at the upper. Work was therefore begun at the gorge or forebay end. In order to avoid shattering the rock walls, with subsequent rapid weathering, and to provide for a smooth surface, offering a low frictional resistance to the flow of water in the canal, the use of channeling machines was decided upon. Twenty Sullivan duplex "VW-61" channelers, air operated, are in use. These are the most powerful channelers made, having two eight-inch chopping engines striking alternately, and capable of cutting to a depth of 20 feet. They take air at 100 lbs. pressure and maximum efficiency is secured by the use of special reheaters, mounted on the frames of the machines. This is the same type of channeler as those recently employed on the Welland canal, except that the latter were steam machines. These channelers are shown in operation in the photograph on page 1103. Ten machines are now at work on each side of the canal, on continuous track, in batteries. This arrangement is a common one in building stone quarries, especially in the Bloomington-Bedford district of Indiana, but is seldom seen on a construction job. It secures an absolutely straight cut on the surveyed line, and a better rate of progress than if the channelers were placed scattering along the canal. For one thing, the sludge or mud at the bottom of the cut is kept constantly agitated, and does not have a chance to settle and form a cushion.

Portable Blacksmith Shop for Channeler Steel



One of the 800 H. P. Electric Shovels. Loading cars 86 feet above the rail

An element of competition is also brought into play between the machines on the two sides of the canal.

The channelers are cutting at the average rate of about 200 square feet per ten-hour day per machine, which is good progress in this stone, considering the depth of the cut (20 feet). To eliminate delay due to lack of sharp steel, a portable blacksmith shop was built, and runs on tracks laid on the center line of the canal. In this shop on wheels a Sullivan all-hammer drill sharpener is used to sharpen the three-piece gang steel for the channelers. The importance to rapid and efficient channeling of an adequate supply of steel, with bits of proper shape, angle of cutting edge and of uniform gauge, properly tempered, cannot be over-estimated.

ROCK DRILLING

For drilling the rock between the channeler cuts, 25 Sullivan Hy-speed hollow piston drills are employed, with 3⅝-inch cylinder diameter. These machines employ 1⅜-inch hollow steel. The advantage derived from the use of hollow steel is, that for each stroke of the piston, the bit has a clean cutting surface, the cuttings being blown out of the hole as rapidly as they are made. In this way none of the force of the blow is absorbed in grinding up the cuttings. This is very evident to the onlooker, for when one compares the cuttings accumulated around the collar of a hole in which hollow steel is being employed, one will note that they are very much coarser than the cuttings around the collar of a hole of a drill using solid steel. These drills are mounted on Lewis hole tripods, which permit the drill to be slid along the front bar, off the steel. This mounting, for deep holes and heavy steels, saves much time on steel changes, as the tripod remains in a fixed position, and the weights do not have to be shifted.

With these drills, holes from 9 to 14 feet deep are placed in rows in the usual manner, spaced seven feet each way. The number of holes shot at one blast is,

however, unusual, ranging as high as 1200 or even 2000. The holes are first sprung with from three to seven sticks of powder, then reloaded with 25 to 40 sticks of dynamite, running from 40 to 60 per cent strength. In one of these shots, in the forebay, 30,000 pounds of powder were used. An ingenious method of connecting up the holes was worked out to insure that all were exploded. A current of low relative voltage but large amperage was used, and the firing was done with a single switch. The picture of the drills on page 1104 shows how fine the rock was broken by this method of shooting. About 60,000 cubic yards were produced by one blast, small enough for the shovel.

Sullivan Air Tube Rotators are employed for drilling large boulders, trimming up walls, etc. They will also be used, it is planned, for the excavation of the wheel pit. It is expected that the broken nature of the rock will necessitate lining the walls with concrete below water line.

ANGLE COMPOUND COMPRESSOR PLANTS

The Sullivan drills, as well as the channelers, are operated by compressed air at 100 pounds pressure, supplied from two central multi-unit compressor plants. One of these is near the Whirlpool, and the other at Montrose, at the river end of the canal proper. The first plant contains eight Sullivan angle compound air compressors, size 20x12x14 inches, with a free air capacity of 1100 cubic feet each, or about 8800 feet in all. At Montrose four similar units are installed. These machines are operated by short belt drive from alternating current electric motors, and are equipped with total closure unloading devices on the inlet openings. An automatic relief valve is also provided on the high pressure cylinder, which pumps out air remaining in the intercooler or high pressure cylinder during no load periods, thus further economizing power. Three-pass, counter current intercoolers are employed, and provide high efficiency. The flexible capacity afforded by these two plants permits economical operation at all load factors. After-coolers are in use, and reheaters will probably be set up near the drills during the winter. The main air line is ten inches in diameter.

Two Sullivan drill sharpeners of the all-hammer type, also air-operated, maintain an ample supply of sharp steel for the rock and hammer drills.

Six of the 20 Sullivan Duplex Channelers at work on the canal

Battery of Sullivan Hyspeed, Hollow Piston Rock Drills

MUCK DISPOSAL

Much of the rock excavated is suitable for use as aggregate for concrete in the linings, etc., and for this purpose a portion of it is crushed in a 250 H. P. 60x84-inch Traylor jaw crusher. Along the river section, the spoil is dumped on the bank on the head side of the cableway. Along the canal, however, the rock and earth muck are loaded by the shovels into 20-yard automatic Western side-dump cars, of which the Commission owns 150. A large dumping area is provided at St. David's, not far from the center of the work, and the spoil is hauled to the dump on the construction railroad which parallels the line of the canal. This railroad is standard gauge, and double tracked. It will eventually total the equivalent of 40 miles of single track.

Incidental construction work on this big enterprise is a large item in itself, including, as it does, ten concrete arch bridges, three of them carrying railroads, and a reinforced concrete intake structure, calling for extensive cofferdam work in the Niagara River. An elaborate crushing, storage, conveying and concrete mixing plant is also a feature.

Sir Adam Beck is chairman of the Hydro-Electric Power Commission of Ontario, Federick A. Gaby, chief engineer and Henry G. Acres, hydraulic engineer. Mr. J. B. Goodwin is works engineer in charge of construction, with G. H. Angell as general superintendent, A. C. D. Blanchard as field engineer and R. T. Gent as electrical and plant engineer.

JOIN THE RED CROSS!

Are you a member of the American Red Cross? During Christmas week you will be asked to become a member or to renew your previous membership. The dues are nominal, but make a large sum in the aggregate, which pays the expense of operations of the society, and provides for emergency civilian relief. It is your privilege as an American to belong to this splendid society which has done so much to help win the war. Be ready.

HETCH-HETCHY DIAMOND DRILLING

By R. P. McGrath*

The accompanying photograph shows a Sullivan Diamond Core Drill mounted on a barge and making test borings in the Tuolumne River, in the Yosemite National Park, California. This work was done during the past year by the International Diamond Drill Contracting Company in the Hetch-Hetchy Valley, with the object of determining the best location in the river bed, for a proposed dam, which is to be a part of the great Hetch-Hetchy Water supply system for San Francisco.

In all, 20 holes were drilled to bed rock through boulders and broken formation. The depth of these holes drilled in the river, varied from 79 to 276 feet. Most of them were rather more than 200 feet in depth. The drill used was a Sullivan Class "C" hydraulic feed machine, operated by steam from a portable boiler located on the river bank. Size "E" rods were employed for the coring work, removing a $\frac{15}{16}$-inch core. The difficulties of the work are indicated by the photograph, showing the force of the current, and the rough water that was frequently encountered. In some cases following heavy rains, the water rose as much as 10 feet in nine hours.

The reliability of the diamond core drill for this class of test boring, to determine the exact location and character of the bed rock, is indicated by the fact that boulders, 30 to 40 feet in diameter, were penetrated in some cases. If this work had been done with some other type of drill, it is probable that such boulders would have been recorded as bed rock, thus giving unreliable information and leading to false conclusions, which might have resulted in serious loss later, had the dam been constructed on the basis of such information. The contractors were successful in getting down all of the 20 holes to the necessary depths and the results obtained were satisfactory to the engineers in all particulars, giving them the exact, accurate information desired.

*582 Market St., San Francisco

HOW RADIUM IS MINED

By Wallace T. Roberts, M. E.*

It is perhaps not generally known that, aside from the other mineral wealth for which the State of Colorado is noted, 95 per cent of the world's supply of Radium is mined in that state. In Montrose County in southwestern Colorado, extending through the Paradox Valley over into Utah, are large deposits of carnotite ore, encircling the base of the La Sal Mountains.

Radium, known as perhaps the most valuable mineral in the world, as well as the most elusive, is in tremendous demand not only for medicinal purposes, but also for commercial uses. Some of these include the dials of indicators, or watch faces, (for illuminating purposes) and for this work it is of great value for aeroplanes and other war apparatus. While gold is worth a little more than $20.00 per ounce, Radium is worth perhaps $3,500,000 per ounce or $140,000 per gramme, the usual unit of measurement. About three hundred million units of carnotite ore are required to produce a single unit of Radium. From this will be seen what a tremendous amount of ore is necessary in order to produce Radium in "commercial quantities."

About half a dozen companies have holdings in the Colorado and Utah fields, but not all of these are in operation. The largest of these undertakings is the Standard Chemical Co., with general offices in Pittsburgh and head field offices at Coke Ovens in Montrose County, about four miles from the town of Naturita, which in turn is about 40 miles from Placerville, the nearest railroad point. The Company's mining property extends over some 400 square miles of the rather desolate country characteristic of this part of the state. The Radium Company of Colorado, Inc., is another operating company. The accompanying photograph of a portion of the San Miguel Valley illustrates the general character of the landscape.

*Equitable Bldg., Denver, Colo.

San Miguel Valley, Montrose County, Colorado. The radium ore is found just below the crests of the plateau at right and left

While not as rugged as some of the mountainous sections of Colorado, the carnotite areas are wild and inaccessible and were reached by horseback over wilderness trails when the presence of the ore was first discovered. Today, after several years of development, many of the camps are reached by trail only, but many miles of good roads have been built and are being maintained. The ore deposits are found beneath the surface of the high plateaus, rising some hundreds of feet above the streams, as shown in the photograph on page 1106.

PROSPECTING

In most of the occurrences the existence of the ore body is not indicated at the surface. It is usually found some 15 to 50 feet below ground and is most irregular in extent and formation. The ore body is usually situated immediately below a layer of sharp sand stone and is usually underlain by a streak of clay. Ore is sometimes found below the clay streak, but not as a rule. It may occur as a boulder of small dimensions or be comparatively large in extent; it may be in the form of a replaced tree trunk or a deposit covering an acre of ground. Some of the replaced trees are complete, even to bark, wood and twigs, well preserved in form.

DIAMOND DRILL PROSPECTING

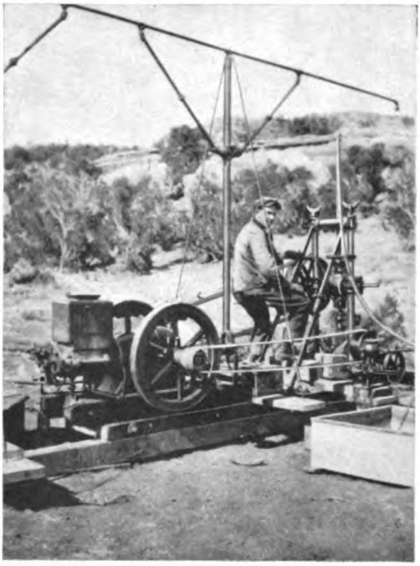
An extended and painstaking campaign is necessary to prospect such a region and make it commercially profitable. The Standard Chemical Company employs two methods of prospecting, both by means of drills. The first of these employs the Diamond Core Drill. A series of holes is first planned by the engineer, covering a given acreage, at intervals of about 25 feet. If one of the holes indicates the presence of values, a secondary series is then drilled around it, sometimes only a few feet apart. The full extent of the deposit is thus determined, as well as the value obtainable, before development is undertaken. When a mine is opened, prospect holes are frequently drilled ahead to make sure that no deposit has been missed. The patience and also the cost and effort required will be seen to be considerable. With the Diamond Drill holes 40 to 50 feet in depth are commonly put in, this being, as stated, the limit of occurrence of the ore below the surface.

The rig most used, of which a number have been in the district for several years past, is the Sullivan Bravo machine, operated by a belt from a gasoline engine. Such an outfit is shown at the top of page 1108. The drill, engine and pump for forcing water down the rods are mounted on heavy timbers with low wheels, so that moving from hole to hole is an easy matter. The great number of prospects and their shallowness makes this a handy arrangement. In this formation the rate of progress is perhaps 30 feet per shift. The cost is low because of this high speed and because the diamond wear is nominal. At first bortz was used in the bits, but latterly black diamonds or carbon are employed, such as are used in all hard mineral formations in these drills. While the initial cost is more, the cost per foot of drilling is much less. Substitutes for the Diamond Drill have been tried, but the combination described above has proved most economical.

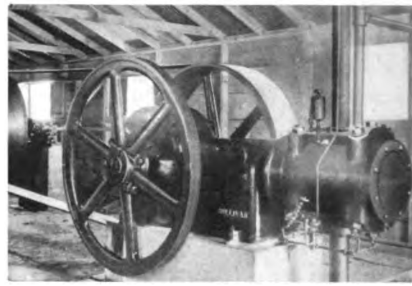
The drills are operated by a crew of two men with a general foreman in charge of several machines.

PROSPECTING WITH ROTATORS

Another method of prospecting, still more widely used, employs Sullivan Air Tube Rotator Hammer Drills, weighing 39 pounds each and operated by one man. These machines are used for the shallower holes, seldom exceeding 30 feet in depth. They employ hollow drill steel in two-foot changes. A jet of live air, carried down the steel to the bits, acts to blow the cuttings to the surface in spite of such



Sullivan "Bravo" Drill, belted from gasoline engine, testing Carnotite deposits in Colorado. The overhead frame supports a canvas cover, used to protect the drill in bad weather.



One of the Gasoline Engine Driven Sullivan Compressor plants

One of the mine openings of the Standard Chemical Company

Part of Burro Train packing water in Tanks for the Diamond Drills

Carnotite Ore Sacked for shipment to the mill

Many miles of road have been built to open this wild country. Even F- - ds still find the climbing hard!

obstacles as clay seams, which are frequently encountered. The powerful rotation of the drill is a factor in enabling it to work successfully to such a depth. Light steel tripods are used to lift the longer lengths of steel. At intervals, or if trouble with dust arises, the steel is withdrawn and a blowpipe used to clean the hole. The cuttings may be preserved at the surface for examination or test in the laboratory, as is the core from the Diamond Core Drills.

These Sullivan Hammer Drills are operated by gasoline engine driven air compressors of the Sullivan WG-3 type, one of which is shown in the accompanying picture. Air is frequently piped several hundred or even thousands of feet from the compressor plant.

DEVELOPMENT

The carnotite mines in a technical sense are seldom "mines" of much size or elaborateness, owing to the limited extent of the deposits of ore. When a body has been sufficiently mapped out and when production is desired from it, a slope is driven and the mining is accomplished with the air tube Rotators described above. Mining is done in the ore under the sandstone strata, on a specialized room and pillar system. The slope is so driven that the tracks are lower than the mining floor. The ore is carried from the face in wheel-barrows and dumped from these into the cars. These cars are of small capacity and are hauled up the slope by a windlass or a small air hoist. They are then dumped on to a sorting canvas or platform where the ore is sorted by hand by men skilled in judging by eye as to the grade of the ore. It is surprising to see how accurately this is done even with the lower grades. One of the cuts on page 1108 shows one of these slopes or mining openings and the dump at the right. Very little of the carnotite ore runs above 5 per cent in grade. The values, consisting of uranium oxide, U_3O_8, vary in grade from perhaps one-half per cent to seven per cent. Ore that must be milled is sent to a concentrator about 12 miles from the offices at Coke Ovens, and from four to 25 miles from the various camps. Shipping ore, including that above 2½ per cent, is sent to the Company's works in Pennsylvania. All ore is placed in sacks, weighing 100 pounds per sack, as it is sorted, owing to the great value of the contents. No attempt will be made to describe the concentrating processes, which are the result of much experiment.

A by-product of uranium oxide occurring in this ore is vanadium; and uranium is also found. The former is used extensively in the manufacture of certain special steels and the Company's shipments of this mineral are among the largest made by any producer. The Company has developed a uranium steel which has advantages over others. One of these consists in the fact that before hardening it can be easily machined, while after the hardening process it is fully as hard as other special steels.

TRANSPORTATION AND SUPPLIES

The transportation of machinery, materials and other supplies to the various camps is a difficult one. Many of the camps are reached by trail only and these trails wind up the mountain-side for hundreds of feet. Burros are used to haul the smaller packages, but in case of large, heavy pieces of machinery, etc., block and tackle and other emergency methods must be employed. Where roads have been built, motor trucks, sometimes equipped with trailers, carry heavy loads, bringing in supplies and taking out the ore. Water for camp use, for the drills, engines, etc., must in most cases be packed up from the river bottoms by burro trains. One of these is shown bringing water to the Diamond Drills.

ORGANIZATION AND FIELD PLANNING

The character of the mining enterprise, consisting of numerous isolated camps and

prospects, requires careful and systematic methods of planning and recording the work. The field management has worked out a system of graphic maps and plots always kept up-to-date on the basis of the daily reports from the different camps, which show the progress being made in any and all departments at all times. For instance, the prospect holes are plotted and the quantity and percentage of carnotite ore promised by each are graphically shown. The development work and the progress of mining are plotted, indicating the existence of the ore, the development of the prospect and the progress of mining. Reports from each camp are telephoned in every night and are tabulated on special forms. The result of this is that the general superintendent can put his finger on every phase of the work from prospect hole to stope or cross-cut, and know just what is being done and whether proper progress is being made.

A Sullivan Rotator prospecting for Carnotite. The dust shows how well the air jet cleans the hole

The same care and system is employed in the handling of supplies and shipments of ore. The motor trucks report their progress both inbound and outbound at certain specified points. If a repair part for an engine is wanted while in transit on one of the regular freight trucks, a special trip can be made by automobile to meet the freighter and rush the part to its destination with the minimum of delay.

Credit for this systematic handling of a difficult natural and technical problem falls largely to Mr. John I. Mullen, who has been in charge of the field work for the Standard Chemical Company since its inception. To his efforts, energy and perseverance is due much of the development of this inaccessible country. Before the days of roads he spent much of the time in the saddle surveying and laying out claims for his Company. This work has amply repaid the effort, for more than ten times the amount of carnotite ore has been shipped from this property than was estimated by engineers to exist in the country. Acknowledgement is made to Mr. Mullen for courtesies in connection with photographs, etc., used in this article.

HOW LARGE A COMPRESSOR SHALL I BUY?

By Lee A. Knights*

In selecting an air compressor for a new mine, quarry or contract, the first consideration is naturally to determine what machines or tools and how many are to be operated by the air power.

Practically all handbooks on compressed air, and many manufacturers' catalogs, have for many years contained tables purporting to show the air consumption of a number of different drills of various sizes.

*Claremont, New Hampshire.

It is obvious that a table cannot be prepared that will be correct for all conditions, as for instance; if eight drills were working in two headings of a tunnel it is probable that all of them would be working at the same time and would, therefore, require eight times the amount of air that a single drill would. If, on the other hand, eight drills were scattered around over an excavation to be used for putting in "pop" holes, it is extremely unlikely that over five or six would ever be working at the same time, so a compressor supplying five or six times enough air for one drill would be ample to take care of the entire eight.

A little reflection will show that the only factors that need to be seriously considered in estimating the requirements to take care of a number of drills, are the air consumption of each drill and the greatest number of drills that will be operated at one time. If the air receivers are of exceptionally large capacity, they may be counted on to assist materially in carrying the peak load, but under the majority of conditions, the receiver capacity may be disregarded, as receivers are usually only large enough to equalize the fluctuations in pressure due to the pulsation of the compressor, and serve merely as equalizers and not as storage reservoirs.

In comparatively large installations, by which is meant those of twenty or more drills, the compressor capacity may be estimated from the probable average reciprocating time of the drill. For instance, if fifty drills are to be installed and it is expected that each one will be actually running 75 per cent of the time, the air required will be 75 per cent of the amount of air one drill takes, multiplied by 50. This method of estimating should only be used for comparatively large installations. For instance, if two drills are to be installed, which will probably run 75 per cent of the time, it is, of course, necessary to furnish compressor capacity enough for the two instead of one and one-half; since both would be working at the same time. This method of estimating should never be used unless the probable lost time of the drills is equal to at least one drill. That is, 75 per cent of 2 equals 1½. 75 per cent of 3 equals 2¼. 75 per cent of 4 equals 3. Therefore we could expect only three drills out of four to be working on the last mentioned installation and could, therefore, plan on compressor capacity enough for three drills. We cannot, however, assume 2¼ out of 3, as it is evident that either two or three drills will be working and so it would be necessary to have enough air to run the entire three.

OTHER AIR USES

In addition to the actual requirements of the drills or other main installation of machinery, a liberal allowance should be made for use in other machines such as pumps, motors and forges; and also for leakage. It is folly to attempt to discourage the legitimate use of compressed air, for this is a very economical and efficient method of transmitting power and accomplishing certain results, but great emphasis should be placed on the unnecessary waste of it, especially by leakage.

LOSSES FROM LEAKAGE

Very few people fully realize the losses due to leakage of compressed air. A hole 1/16-inch in diameter will cause a loss of about six cubic feet of free air per minute at 100 pounds pressure. A ⅛-inch hole will allow a loss of over 25 cubic feet per minute, or enough to run a small tool. A ¼-inch hole will allow over 100 cubic feet per minute to escape, or enough to run a modern rotating hand hammer drill or a stoper. It is seldom that the leakage from a ¼-inch hole would go unnoticed, but a multitude of smaller leaks are frequently allowed, which reduce the total efficiency of the installation to an almost unbelievable extent.

It is only necessary to run the compressor through the noon hour, or at some other time when no machines are working, to see just how many revolutions the compressor has to make to take care of leakage alone, since at that time no effective work is being done. If it requires 50 revolutions of the compressor per minute to keep up the pressure with no machines running, it is evident that if the compressor is normally running at 200 revolutions per minute, only 150 of the revolutions are furnishing air for efficient use, and the other 50 are merely taking care of the leakage. Unfortunately, this test is very likely to leave one with a rather unsatisfactory opinion of the plant; but it serves the useful purpose of impressing one with the necessity of making a liberal allowance for leakage in future installations, and still more important, makes it easy to keep leakage at the minimum, by checking up on this loss from time to time, as machines are added and pipe lines extended.

The same considerations, of course, apply to cutting shed, foundry or shop air power plants.

IDEAL SHOP FOR SHARPENING DRILL STEEL

By George H. Gilman*

[Owing to the limitations of space, it has been necessary to divide Mr. Gilman's article into two parts. The next issue of Mine and Quarry will contain the second section of it. If any readers wish the complete article at once, a few reprints are available.—*Editor.*]

The rock-drill bit had been justly termed "the business end of rock excavation" and it is, therefore the logical starting point in the campaign to improve drilling efficiency. The importance of the size and quality of the drill steel and of the shape and temper of its bit and shank ends has been emphasized. The purpose, therefore, of this paper is to advance suggestions relative to an efficient method and satisfactory means for the production and upkeep of rock-drill steel.

The suggestions advanced in this paper have been gained only as the result of a personal investigation of a great variety of conditions in different sections of the country, made possible by the co-operation of a great many mining companies.

The selection of the best form of equipment to meet a given set of conditions is dependent upon a number of factors, and the extent to which it is profitable to go, in providing facilities for a drill-steel equipment, is largely governed by the volume of material to be handled, which may be determined by the number of rock-drilling machines employed and the character of the ground. In general, it may be assumed that for a mine or other permanent rock-excavating plant of sufficient capacity to warrant the installation of a mechanical drill-sharpening machine a drill-steel plant equipped with the facilities herein described and possessing the following qualifications is warranted.

PRIMARY REQUIREMENTS OF A SHARPENING PLANT

Primarily a drill-steel plant having one mechanical sharpener should be designed so that the output of the smith and his helper may be doubled by the addition of two men, without any increase in the original shop equipment being necessary, and to provide for possible growth, it should be so constructed that by adding space and certain features of equipment to one end only of the building the capacity may be increased further at slight expense without making any change in the original equipment; that the various operations required to make the drill steel and to reforge and temper used steel are

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performed with the fewest possible movements and with the least amount of exertion on the part of the operator; and that the character of the work when executed conforms with the established standard for the existing conditions.

To secure these results the building should be of such size that the various machines and their appurtenances may be placed in the most advantageous position. It should be built of materials that are accessible and in conformity with the standard surface equipment of the mine. It should be lighted in such a manner that the piece being worked upon and the operating end of the machine employed are clearly visible to the operator, so that his vision of the parts is not obstructed by shadows; in addition, to meet the requirements of a shop of the size and type herein described, certain features of equipment are recommended in Table I.

In order to obtain maximum efficiency in a drill-steel plant it is essential that the transportation of the drill steel be accomplished expeditiously and with a minimum effort, for, regardless of how suitable the mechanical equipment may be, it is impossible to secure and maintain maximum production from the machines and furnaces if a suitable means of transportation conforming to the requirements of the plant is not provided.

To meet the requirements of the type of plant described in this paper it is recommended that the shop, Fig. 1, be equipped with a permanent track and turntable the gage of which corresponds to the standard gage of the mine or quarry tracks, provided such gage does not exceed 36 in. For transporting the drill steel to and from the shaft, or loading platform, a division car of the Copper Queen type, Fig, 2, described in the *Engineering & Mining Journal*, June 24, 1916, will be found to meet the requirements satisfactorily. This car may be equipped with a body detachable from the truck to facilitate the work of transferring the drill steel to the mine skip, cage or wagon without removing the bars from the receptacle, or it may be employed for the purpose intact, and in the case of a mine

TABLE I.

EQUIPMENT FOR DRILL-STEEL SHOP

TRANSPORTATION
106 Ft. of 24-in. gage track (rail 35 lb. per yd.) comprising 36 wood ties 4 x 6 x 36 in.
4 Mine-car turntables — 24-in. gage
1 Turn plate (if required)
3 Compartment cars with revolving body (Copper Queen type)
3 Division cars with detachable body (Copper Queen type)

FURNACE
1 Forging furnace (oil or gas burner)
1 Tempering furnace (oil or gas burner)
2 Drill-steel supports for furnaces
2 ventilators with hoods for furnaces
1 Oil storage tank
1-in. pipe with fittings for low-pressure air supply
½-in. pipe with fittings for fuel supply
2 Pyrometers, equipped with base metal couples having indicating voltmeter and cabinet
¾-in. electrical-conduit piping (for pyrometers)
2 Pyrene fire extinguishers

SHARPENER
1 Drill sharpener with full equipment of dies and dollies including supplementary gaging dies and pneumatic-hammer punch.
1¼-in. pipe with fittings for compressed-air supply
1 Storage cabinet for drill-sharpener appurtenances
2 Suspended drill-steel supports (for sharpener and grinder)
1 Floor grinder (direct electric-driven) with two grinding wheels 18 x 3 in.
1 Electric switchboard for motor

TEMPERING
1 Rotary quenching and tempering machine (Homestake type), with 1-hp. motor
1 Electric switchboard for tempering-machine motor
1 Oil-quenching tank with cyanide receptacle
1 Ventilator with hood for cyanide receptacle

RACKS, TABLES AND ACCESSORIES
1 Inspection and bundling rack with incline, equipped with one gage cabinet
1 Storage rack for drill-steel bar stock
1 Storage rack for finished drill steel
1 Used steel table

SANITARY EQUIPMENT
1 Sanitary drinking fountain
4 Steel double-deck lockers
2 Wash basins
1 Sanitary towel rack
1 Urinal
1 Flush bowl
1 Emergency cabinet

GENERAL EQUIPMENT
1 Work bench equipped with 5-in. machinist's vise
1 Desk with drawers and hinged top
1 300-lb. anvil
1 Set of hand chisels and sledges
2 500-watt Mazda lamps with reflectors
1 60-watt Mazda lamp with reflector
Water piping
Compressed-air piping and hose equipped with Davies blowgun
Waste piping
Oil piping
Electric wiring
Concrete floor

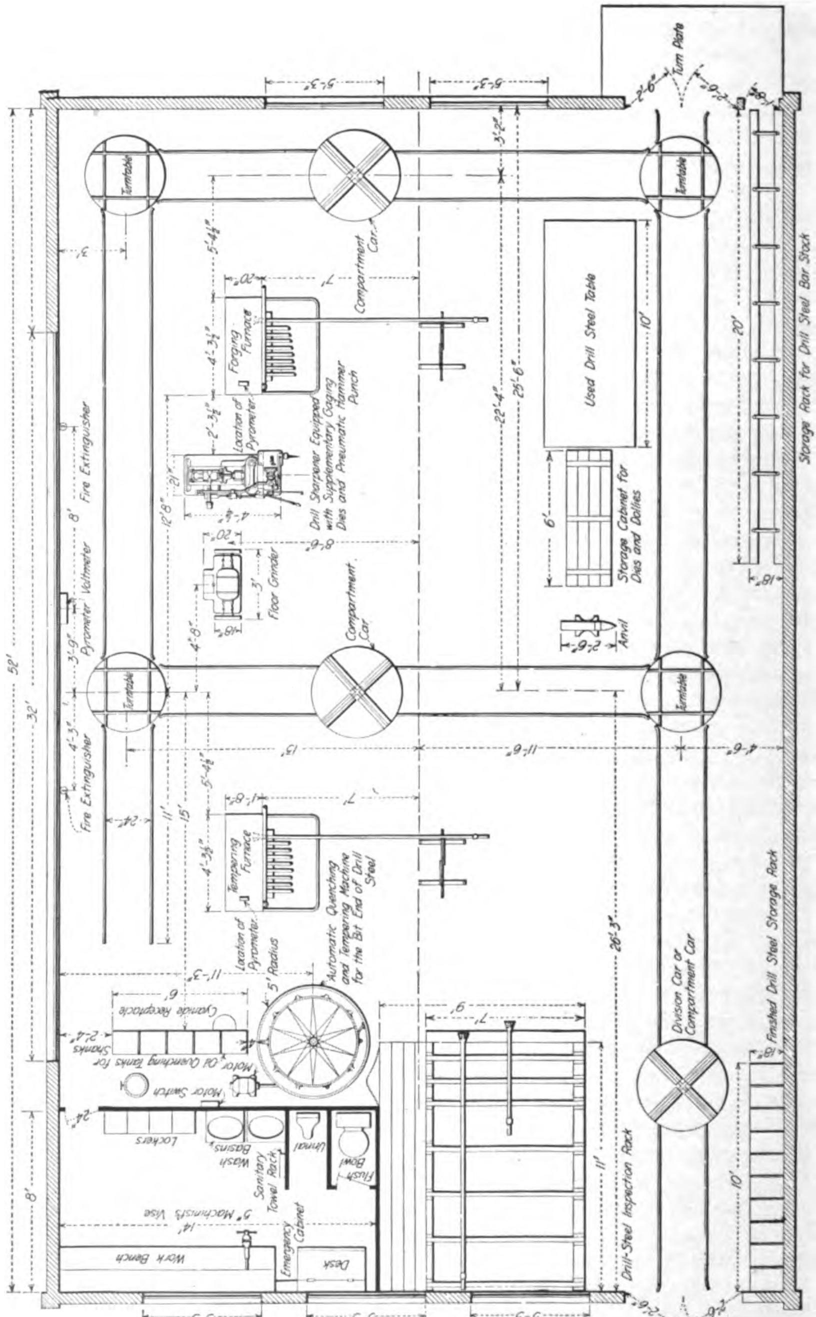


Fig. 1. Floor Plan of Ideal Shop for Sharpening Steel

the whole may be lowered to the different levels where the distribution of the steel may be made in conformity with standard practice. Of the many forms of carriages or trucks employed for the transportation of the drill steel while it is in the transition stage during the process of working, that developed by the Copper Queen Consolidated Mining Co., and described in the article referred to, is perhaps best adapted for a drill-steel plant of this general type.

The compartment car, Fig. 3, consists of a truck having the wheel gage corresponding to the track standard, on which is mounted a revolvable compartment body supported by a ball bearing and equipped with a latch for locking the body with relation to the truck in any desired position. This car is employed for transporting the steel from the sorting table and the oil-quenching tank to the heating forges. In it the various lengths of steel are segregated and by virtue of the revolvable body the insertion and removal of the drill steel is accomplished advantageously. Subsequent to the final heating of the bit the steel is transported mechanically by the tempering machine and deposited upon the inspection rack Fig. 4, whence it is loaded into the division car and transported from the shop.

The four turntables with which the track system is equipped provide means for the cars to be bypassed at any point except the dead end and, by having the main line extend through the building longitudinally, a convenient means is provided whereby the track system of the shop may be in intercommunication with the yard system and the other departments of the mine plant. At the outside of the building adjacent to the main entry a turn plate is provided, composed of boiler plate ⅜ in. thick, to facilitate the switching of the cars to and from a series of tracks from the yard system which may terminate at the outer edge of the plate.

HEATING FURNACES FOR FORGING AND TEMPERING

The heating of rock-drill steel preparatory to forging and tempering the bit and shank end is an engineering problem and it must be considered as such if maximum efficiency is to be obtained. The success of the furnaces employed depends upon the type and the method adopted for their operation. In order to perform their function in the most uniform and economical manner they must be constructed according to scientific principles in which the following considerations serve as a basis:

1. Size and shape of the drill steel to be treated.
2. Quantity of drill steel to be treated duting a specified time.
3. Temperature required to insure proper results, and means for its regulation and maintenance.
4. Local conditions.
5. Most convenient and economical cycle of operations.

Gas as fuel is recommended where it is available at low cost, but as oil is of necessity adopted in a large majority of mining camps in this country, the employment of either as a heating agent will apply to the type of furnace described herein. For present-day requirements of the average mine or quarry, situated in many instances in remote and inaccessible places, where the carrying of a varied stock of refractory material is not only difficult but also expensive, simplicity of furnace design with special regard to repairs should be considered primarily. With this in view, the refractory material used in the construction of a furnace should be composed solely of standard-size firebrick, procurable in almost every local market, and it should be assembled in such a manner as to enable any blacksmith to repair or rebuild it with ease and success.

The heating chamber of the furnace should preferably be of such size and shape, and its burner so positioned,

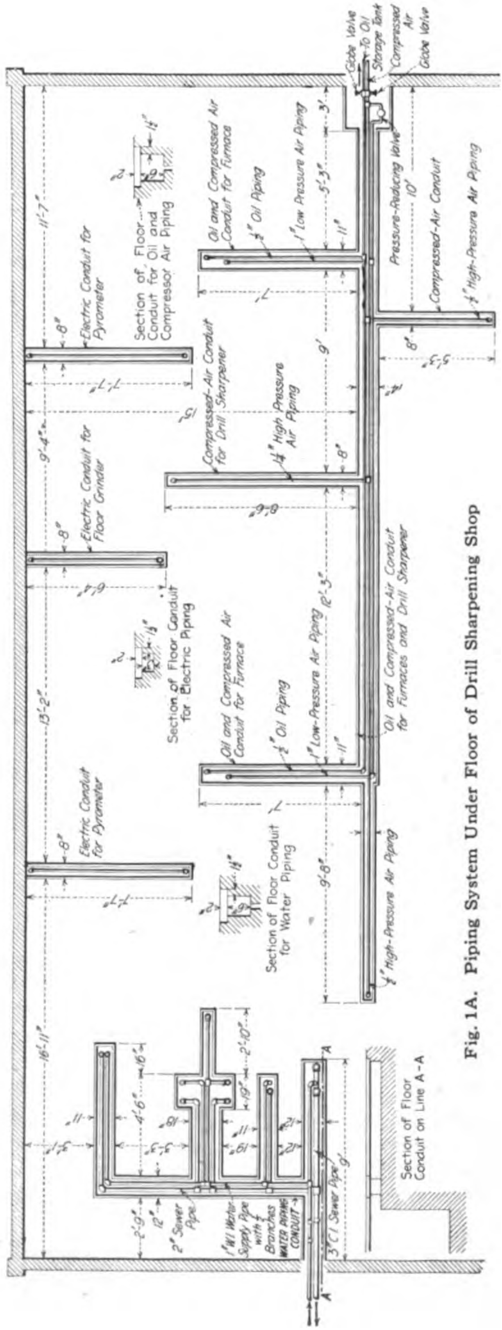
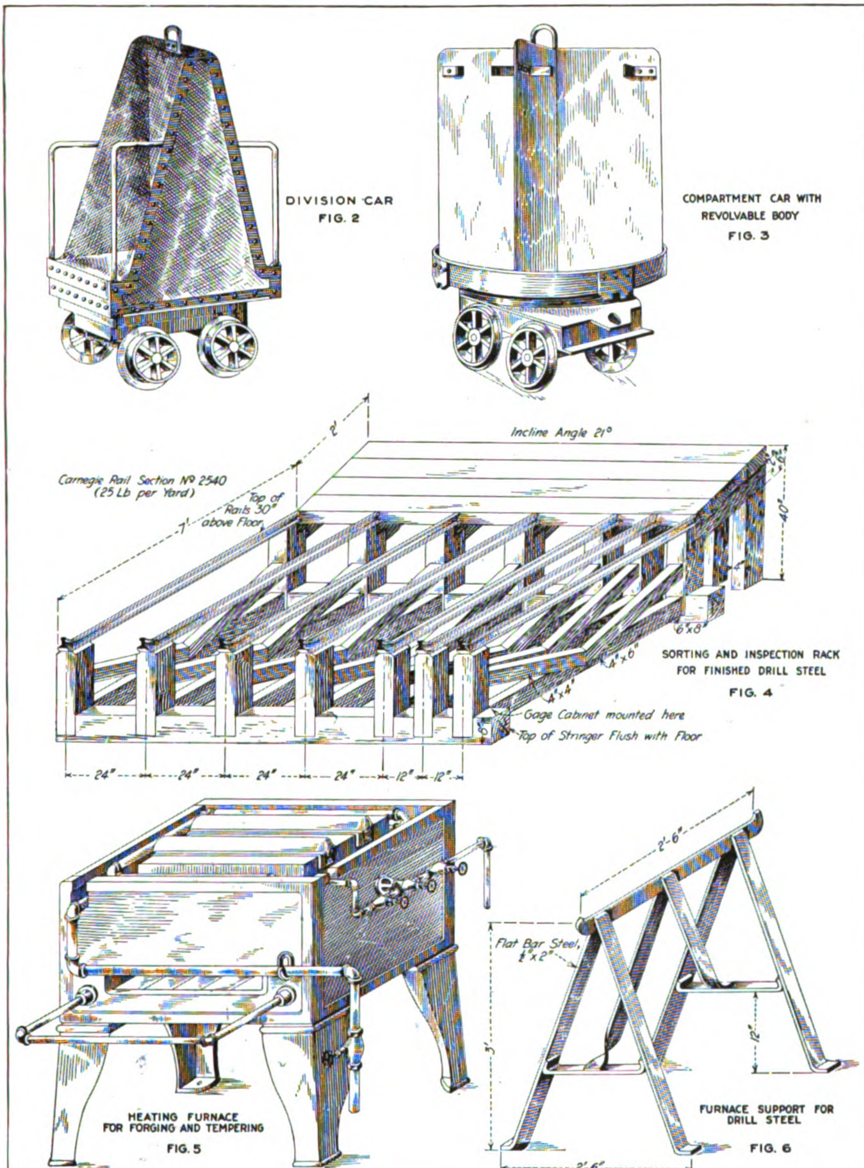


Fig. 1A. Piping System Under Floor of Drill Sharpening Shop

that the steel is heated by reflection or radiation rather than by direct impingement of the flame on the metal. This will prevent blistering and reduce the formation of excessive scale which is likely to result if the flame is caused to play directly on the metal. The heating chamber should be of such size as to absorb economically the heat of the products of combustion.

A certain amount of flexibility that may be taken advantage of by an untrained operator is desirable, inasmuch as the character of the flame required for heating to the best advantage, standard types of ⅞-in. hexagon and 1¼-in. round hollow steel will vary with the size of the bit and the shape of the drill shank; and, in the case of the lugs or collars on the shank, will require only the heating of that portion to be upset, without affecting the extreme end of the bar, and thus obviate the necessity of cooling the tip before it is inserted in the dies of the drill sharpener. This flexibility may be secured by employing a burner of such construction that a perfectly round or fan-shaped flame is produced at will by the operator by merely adjusting a thumb-screw. Another desirable feature of such a furnace is to have at the end of the chamber from which the drill steel is withdrawn a maximum heat zone of constant and uniform temperature from which the temperature is lowered gradually but to an appreciable degree toward the end opposite where the steel is inserted. This will give the steel time to absorb the heat gradually, and will secure uniformity in the opening of the grain as the steel bars are handled in rotation.



Figs. 2 to 6. Accessory Equipment for Ideal Shop for Sharpening Drill Steel

It has been determined by experiment that a time period of 4 min. is desirable for heating the larger sizes of bits formed on 1¼-in. round hollow drill steel and in order to insure an output of one steel every 30 sec. from the forging furnace,

the mouth or opening for the insertion of the steel should be 2 ft. 6 in. long with a height of 3½ in. Pyrometer readings should be taken from that part of the furnace directly adjacent the drill steel at the point of withdrawal.

If desirable, the low-pressure air supply for the furnace may be secured from the main high-pressure air supply of the mine or quarry, in which case a pressure-reducing valve should be used to secure a terminal pressure of approximately 15 lb. below the lowest fluctuation of the main-line pressure. This reducing valve may be placed in the wall adjacent to the point at which air enters the building, from which a supplementary low-pressure air duct is provided for the two furnaces, as shown in Fig. 1A.

To obtain the best results from any type of burner in point of economy and ease of operation it is of prime importance to have both the oil and the atomizing agent as constant and steady as possible. After passing through the pressure-reducing valve it is desirable to have the air for the furnace supply pass through a pipe mounted directly over and running lengthwise with the mouth of the furnace. In this pipe provision may be made by drilling a series of small holes directed downward—for the escape of a part of the air which will serve the double function of preventing the waste gases from flowing out in the face of the operator—and assisting in keeping cool that section of the drill-steel bar that projects from the furnace. After passing along the mouth of the furnace the air should preferably make two three-quarter circuits on the top of the brickwork, but inside of the cast-iron casing, for preheating it, preparatory to admission to the burner. Fig. 5 shows a furnace constructed along these lines.

The drill-steel support shown by Fig. 6 provides a simple, rugged and convenient means for supporting the drill steel during the heating operation. Constructed from flat bars of ½x2-in. low-carbon machinery steel or wrought iron, it may be made by any black-smith with an ordinary forge-shop equipment.

(To be continued)

FIVE GOLD STARS ON SULLIVAN FLAG

Pvt. W. L. Stanley, Medical Corps, Camp Lee, Va.

Two hundred and sixty employees of the Sullivan Machinery Company were represented by stars on its service flag when "cease firing" sounded on November 11. Five of these stars are gold and two of silver, based on latest casualty lists. May these not be increased by final reports! Of these, 171 had gone into service from the eastern works at Claremont, N. H., 50 from the western works and general offices at Chicago, and 39 from branch offices. A large proportion of these men, as officers and privates, soldiers, sailors, aviators and engineers, saw active duty overseas. The service rendered by those who remained on this side, in training camps or in office positions, while less thrilling, was equally important to the country.

The five gold stars represent Sergeant Olivio J. LaCasse, 103d Infantry; George

Pvt. Patrick Brady (Claremont) Camp Mills, L. I.

Sergt. J. O. Cree (Huntington) Coast Artillery, Ft. Monroe

Pvt. Geo. R. McLeod, (Claremont) 102d Engineers, A. E. F. Killed in Action, Sept. 27.

Harvey Osterholm (Chicago Works), Red Cross Ambulance Driver, Italy.

1st Lieut. Charles H. Tipping, (Huntington) Mobile Ordnance Repair Shop, 1st Division, A. E. F.

Sergt. J. Olivio LaCasse, (Claremont) 103 Inf. A. E. F. Killed in action July 20.

Pvt. George Davidson, (Chicago Office) 122d F. A., A. E. F.

R. McLeod, 102d Engineers; Arthur Baribeau, Camp Upton, and Albert Nailer, Camp Devens; all attached to the Claremont Works, and Private Albert B. Klavunn, Co. A, 355th Infantry, 89th Division, A. E. F., Chicago works.

Sergeant LaCasse was killed in action July 20, in the first days of the allied offensive. He had been in service nearly two years, although only 19 years old, having seen border duty in 1916 with the New Hampshire National Guard. His company was mobilized in July, 1917 and the regiment was sent to France in September, taking over a section of the fighting line on March last. LaCasse was reported wounded, earlier in the year. He was employed in the foundry at Claremont, and his parents reside in that town.

Geo. R. McLeod, 102nd Engineers, age 23 was killed in action in France, September 27th. He was a graduate of Wentworth Institute, Boston and had been a draftsman in the Claremont

engineering department for about two years and a half. He enlisted in November, 1917, going first to Camp Wadsworth, South Carolina, and being sent overseas shortly thereafter.

Pvt. Albert B. Klavunn (Chicago Wks.) 355th Inf. Co. A., 89th Div., A. E. F. Killed in action.

First Lieut. John H. Emrick, (Claremont) C.A. U. S. R. Anti-Aircraft Artillery, A. E. F.

Gunner's Mate Leo W. Barlick (Chicago Works) on Armed Guard Duty.

Private McLeod was popular at Claremont, having been pitcher on the Sullivan Base Ball Team for the seasons of 1916 and 1917. He has two brothers in service.

Albert Nailer, another Claremont boy, was drafted in July of this year, and fell a victim to the influenza epidemic, dying Sept. 25 at Camp Devens. He was 24 years old.

Arthur Baribeau, who died of pneumonia at Camp Upton, N. Y., on Sept. 29, had been in service only since Sept. 5. His home was in Berlin, N. H.

Private Albert B. Klavunn, Chicago works, tool department, was called up for service in March, 1918, and after a brief training period at Camp Grant, was assigned to Co. A, 355th Infantry, and sent overseas to join the 89th Division. His family were notified of his death in action Nov. 30, but have received no particulars. Private Klavunn was 22 years old.

Sergeant John W. Veazey, Claremont, 325th Infantry, A. E. F., was reported in September as seriously wounded in action.

F. W. Glacken (St. Louis Office), is now a Sergeant-Major, attached to headquarters, 89th Division, A. E. F., France.

Lieutenant Austin Y. Hoy, Royal British Artillery, was safe and in London on leave in October.

W. L. Stanley (Huntington), who joined the colors in June, was transferred to the Medical Corps in August, and is stationed at Camp Lee, Virginia.

First Lieutenant Walter F. O'Brien, formerly Juneau Office Manager, reported late in October, that he was on his way overseas, as an instructor in aircraft armament material. He had been engaged in similar work for six months prior to embarkation, at the Wilbur Wright Field, Dayton, Ohio. His address is care of Chief Ordnance Officer, U. S. A., Field P. O. 717, A. E. F., France.

Second Lieutenant William Jean Brown,

formerly attached to St. Louis Office, is now with the Headquarters Company, 39th Field Artillery, at Camp Lewis, American Lake, Washington.

Charles G. Miller, formerly attached to Joplin Office, was returned from overseas duty, in August, with the grade of sergeant and has been assigned to laboratory work in connection with aviation, at St. Paul, Minnesota.

S. A. Benson, now a first Lieutenant, returned to the United States several months ago and is an artillery instructor at Fort Sill, in Battery "B," 57th F. A., Camp Doniphan.

A. G. Collins, formerly attached to the El Paso Branch, was at the San Pedro, California, Naval Training Station, during the summer, was then at Pelham Bay, New York, for several weeks and is now at Stevens Institute, Hoboken, N. J., taking a ten weeks' engineering course. Mr. Collins is studying for his commission.

It is now *Captain* Sidney F. Greeley, Battery "B," 333d Field Artillery. Captain Greeley, formerly Assistant Advertising manager, received his promotion from first lieutenant in September, and is in France with the Blackhawk Division.

Second Lieutenant Frederick W. Copeland, 333d F. A., Battery E., has been overseas since about September 25th.

Lieut. R. A. Lowry, formerly of our Huntington Office, went overseas several months ago with the 28th Engineers and writes from Tours, October 20th, that he is in the Division of Military Engineering and Engineering Supplies at that point.

Leo W. Barlick, 2d Class Gunner's Mate on armed guard duty, visited the Chicago Works late in August. He had made several cruises across the Atlantic. The photograph shows him ready for a Hun "sub."

Miss Anna D. Liberty, Army Nurse, is stationed at the Base Hospital at Camp Sheridan, Montgomery, Alabama. Miss Liberty is the first woman to leave the Company's employ to enter the service.

The following men have entered military service since the last issue of Mine and Quarry.

CHICAGO WORKS LIST

Roy Adams, Army.
David Bokovski, Army.
Clem. Christensen, Army.
P. Hazard, Army.
Wm. Marshall, Army.
Stanley E. Nordstrom, Navy.
Stanley Rasmussen, Navy.
B. Wisniewski, Army.

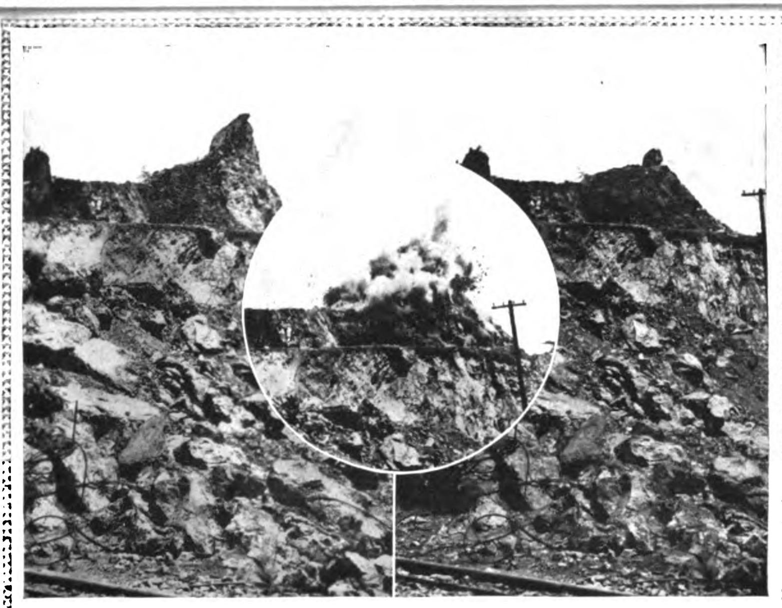
CLAREMONT WORKS LIST

Semon M. Amell, Fort Slocum, N. Y.
Nickle Arsenier, Camp Devens, Mass.
Raymond Bates.
Vernon S. Bates.
Clarence M. Bean, Camp Devens, Mass.
Harvey A. Berry.
Arthur J. Berube, Canadian Army.
Sergt. Joseph Berube, Camp Lee, Va.
Palmer E. Bliss, Sacketts Harbor, N. Y.
Erving D. Blodgett, Camp Devens, Mass.
Pvt. Patrick Brady, Camp Mills, L. I.
Herbert Brooks, U. S. N.
Leo F. Brunelle, U. S. S. Aroostook.
Joseph Chaffee, Durham College, N. H.
Tony Charapowick, Camp Devens, Mass.
Leslie A. Currier, Durham College, N. H.
Vard A. Dennison, Durham College, N. H.
Joseph Drolette.
Charles Durward, Cosmopolis, Wash.
Pvt. Robert S. Forsaith, Hanover, N. H.
Pvt. Napoleon J. Fortin, Durham, N. H.
Ray E. Franklin, Camp McClellan, Ala.
Albert L. Gafeau, Camp Devens, Mass.
Camille S. Giguere, Camp Dix, N. J.
Charles D. Glode, Durham College, N. H.
Frank H. Goodrow, Fort Slocum, N. Y.
Arthur J. Gordon, Springfield, Mass.
Evan F. Griffith, Camp Hancock, Ga.
Pvt. Harland C. Griswold, S. A. T. C., U. of Vt.
Lawrence E. Howe.
L. E. Kelley, Harvard Univ. S. A. T. C.
Pvt. Lloyd W. Kendell, Camp McClellan, Ala.
Pvt. Frank LeClair, Camp Devens, Mass.
J. N. LaMay, Durham, N. H.
Pvt. Joseph Laroch, Camp Devens, Mass.
Pvt. Arthur LaVaude, Durham, N. H.
Miss Anna D. Liberty, Camp Sheridan, Ala.
Pvt. Harold A. Marshall, Fort Oglethorpe, Ga.
Roy Marshall, Camp Devens, Mass.
Pvt. Lewis W. Mayhew, S. A. T. C., Hanover, N. H.
Pvt. Philip Mayhew, Hanover, N. H.
Pvt. Eugene J. Menard, Camp Devens, Mass.
Ralph A. Morgan, Durham, N. H.
Napoleon Nado, Camp Devens, Mass.
Albert N. Nailer, Camp Devens, Mass.
Pvt. Alfred H. O'Connell, S.A.T.C., Middlebury, Vt.
John O'Dowd, Camp Devens, Mass.
John Pashkovsky, Camp Devens, Mass.
Frank G. Perkins, 103rd Inf., A. E. F.
Pvt. Harold O. Pratt, Camp Devens, Mass.
Pvt. Alexander Rennie, S.A.T.C., Middlebury, Vt.
Lloyd L. Richardson, Newport, N. H.
Horace L. Rockwell, Camp Lee, Va.
Pvt. Hubert R. Smith, Fortress Monroe, Va.
Pvt. Van C. Smith, Camp Devens, Mass.
Bert D. Spooner, Camp Devens, Mass.
John J. Springer.
Harry K. Stearns, Camp Upton, N. Y.
Sergt. Henry L. Stone, 303 Field Artillery, A. E. F.
Raoul R. Thibault.
Pvt. Roy Titus, Camp Upton, N. Y.
Parker E. Wright, Camp Devens, Mass.

MINE AND QVARRY

REG. U. S. PAT. OFF.

VOL. XI, No. 2 MARCH, 1919 WHOLE No. 37



Blast on Sacramento Hill. Firing 4 churn drill holes and 12 "toe-holes" by electricity

LONGWALL MINING IN ILLINOIS

DRILL SHARPENER SPEEDS SHIPBUILDING

HEAVY DRILLING AT SACRAMENTO HILL

PVBLISHED BY THE SVLLIVAN MACHINERY CO. MICHIGAN AVE. CHICAGO

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MINE AND QUARRY

REG. U. S. PAT. OFF.

VOL. XI, No. 2 MARCH, 1919 WHOLE No. 37

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address.

THE SECOND INSTALLMENT of Mr. Gilman's article on "An Ideal Drill Steel Sharpening Shop" appears in this issue, and will prove interesting reading for blacksmiths, master mechanics and superintendents who have any considerable amount of drill steel to handle. Existing shops will find that they can, without great expense, readily adopt some of the suggested efficiency-making features, thus securing the benefits of the experience of progressive mines and contractors throughout the country.

SUGGESTIONS of a valuable character for the intensive use of drill sharpening machines are made in an article printed elsewhere in this issue. The Sullivan Sharpener, with its horizontal hammer for upsetting and its vertical hammer for swaging is an all-around machine shop tool, capable of very wide application to all sorts of miscellaneous shop work, which will result, as suggested by the author of this article, in important economy of material, time, and labor.

DO YOU WISH to receive MINE AND QUARRY during 1919? If so, please send us the enclosed reply card. The editors are anxious to send the magazine to every one actively interested in it, and the articles it contains, but owing to the numerous changes in address and occupation caused by war times, it is necessary to conduct a thorough revision of our mailing list, and we wish to eliminate all waste circulation. This is the Spring Election period. Vote "YES" on the card and MINE AND QUARRY will be sent you regularly. Vote "NO" and your name will be dropped from the mailing list. The return of the card in either case is a courtesy we shall greatly appreciate. The editors hope to make MINE AND QUARRY more interesting and useful than ever, during the present year.

Mr. Chester Mott, for nearly two years past sales engineer at Chicago in charge of business in Iowa, Northern Illinois, and Minnesota, has been appointed branch office manager at Denver, Colorado, replacing Mr. Wallace T. Roberts, who recently resigned to engage in other business.

The Sullivan Machinery Company has recently organized a Foreign Trade Department, with F. W. Copeland, formerly attached to the St. Louis office, as manager, with headquarters at Chicago. The purpose of this department will be to coordinate and assist the work of the foreign branches and agents of the company, and to devote the particular attention necessary to correspondence and inquiries from abroad.

The Mexico City branch office of the Sullivan Machinery Company is now situated at Edificio Oliver No. 3. Mr. Joseph F. Bennett, previously associated with the El Paso, Texas, branch office of the Company for many years and an engineer of long experience in Old Mexico, as well as of wide acquaintance, has been placed in charge as local manager. Warehousing arrangements have been made to carry Sullivan Air Compressors, Drills, Drill Sharpeners and their parts in stock for the convenience of customers in Central and Southern Mexico.

LONGWALL MINING IN ILLINOIS

By Chester Mott*

"Simply sink a shaft to the coal and start digging in a circle, allowing the top to fall in." This probably wins as the shortest treatise on the science of Longwall coal mining, but one is likely to accuse the author of being a layman, else he would have included a word or two on how to stop or at least on how to slow down.

Comparatively little Longwall work is done in the United States, though the system is used a great deal in Great Britain. Some seams are admirably adapted for Longwall work and in fact can not be worked economically under any other system. One important field in the United States is the Illinois Third Vein field. It has been worked for more than 60 years, one of the mines now operating having been a producer during the Civil War. This article deals with some of the problems encountered there.

Notable Longwall operators in Northern Illinois are the Spring Valley Coal Co., Spring Valley, La Salle County Carbon Coal Co., La Salle, St. Paul Coal Co., Granville, Illinois Third Vein Coal Co., Ladd, Toluca Coal Co., Toluca, Illinois Zinc Co., Peru. These and other companies have purchased undercutting machines in the last three years. It is curious that a successful machine had not been brought to the field until this time.

The accompanying sketch illustrates the plan of a mine operated on the "advancing" Longwall system. A pillar of coal is left around the shaft to prevent subsidence and a face of circular shape is started outside of this pillar. Roadways are kept open in the worked-out areas, instead of being driven through the coal as is done in Room and Pillar work. Room roads are kept open at the face until they are "cut off" by branches. All roadways are about eight feet wide and are brushed high enough to allow mules to work in them.

*Equitable Bldg., Denver, Colo.

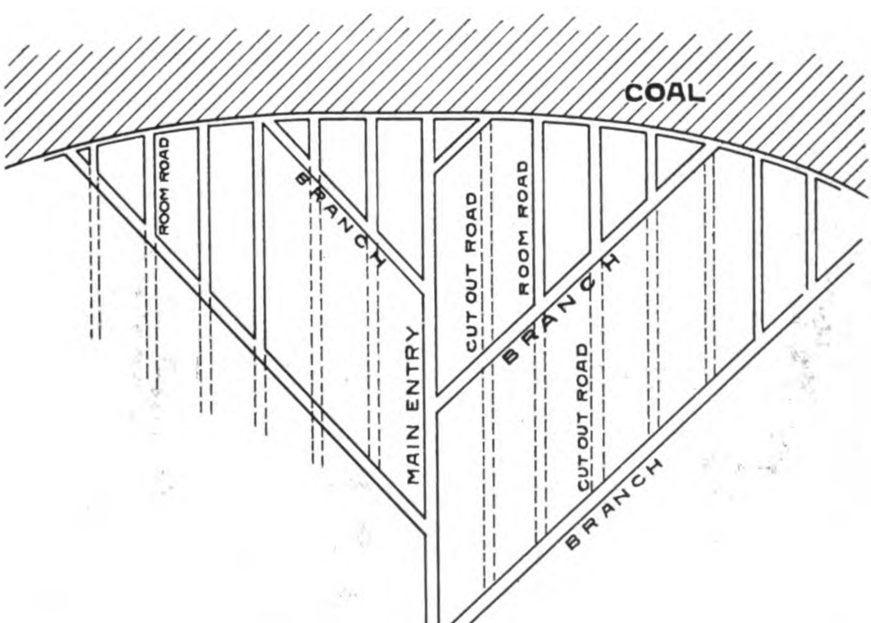
Room roads are 42 feet or 43 feet between centers, and half this distance each way from the road is known as a "place." Necessary support for the top takes the form of "pack walls" or "buildings" put in parallel to the face after each cut. These extend each way from the road, in some cases nearly meeting at the center. They are composed of rock brushed from the roadways and the gob from the undermining.

No explosives are used to bring the coal down. After the undermining is put in, the roof pressure furnishes the force to break the coal down and break it into lumps. No great amount of hammering or wedging can be done in the limited space. The thickness of the "pack walls" and the care with which they are built controls the roof pressure and movement of the top; and great skill is shown in maneuvering this pressure to make it do the work required without overdoing it.

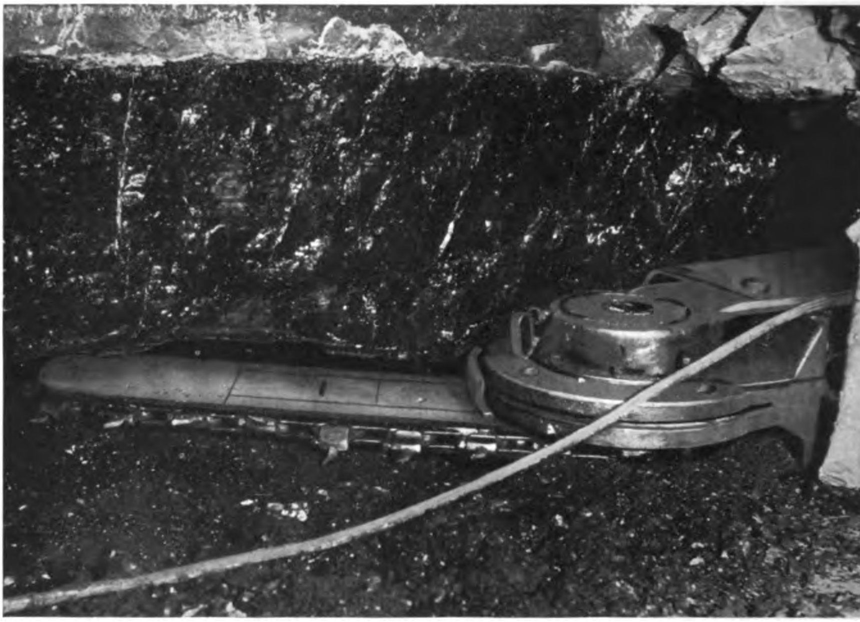
The nature of the top limits both the depth of the undercut and the space between the face of the coal and the "pack wall." There is a break in the top corresponding to each undercut and serious trouble results when it "breaks over" or breaks beyond the depth of the undercut. These breaks should occur over the bottom of the undercut or very nearly so. Since the building has to be put in near enough to the face to support the top, the space at the face can not be over three feet wide in most cases.

As the rock for the "pack walls" must come principally from the room roads, one sees a distinct limit to the height of these walls and therefore to the height of the seam. Four feet is about the limit in height, while seams as low as 19 inches have been worked successfully. The Illinois Third Vein varies from 28 inches to

Top works of La Salle County Carbon Coal Company, Peru Shaft, La Salle, Illinois



General plan of Longwall workings, advancing system, as practiced in the Northern Illinois Field



Ironclad machine at La Salle County Carbon Coal Company, sumping or cutting the bar under the coal. In this picture the bar is moving away from the reader toward a position at right angles with the body of the machine

Ironclad Machine, passing head of road, with cutter bar under the coal. Machine operator may be seen at right end or front of the machine

42 inches in thickness, so it will be that the space at the face is limited to 36 inches wide by 28 inches to 42 inches high, averaging say 36 inches high. An undercutting machine must pass through this space.

Many of the mines in this district have worked until the face is over a mile from the shaft bottom. A glance at the sketch will suggest the miles of haulage way that must be maintained at an enormous fixed expense, though the tonnage possible from such thin seams is necessarily low. Settling of the roof continues in the worked-out area until the top meets the bottom in the roadways and height is maintained by "back brushing." There is no place for this rock underground except in the "cut-off" roads, so most of it must be hoisted to the surface.

Longwall mines have the best of it in ventilation, however, as nearly all of the men underground are at the face and it is a fairly simple matter by bratticing off roads to provide a path of least resistance for the air along the face.

MACHINE MINING RECENT

Sincere attempts had been made several times to do the undercutting by machine, but without success because of inherent defects in the machines. It became evident that a successful machine must meet specifications about like these:

Must be narrow, to pass between the face and the "pack wall."

Must be low to pass under the top.

Must cut in the coal to avoid dust caused by cutting in the mining.

Must be both powerful and rugged to cut the impurities encountered in the coal.

Must be capable of cutting at various heights and quickly adjustable to these heights in order to avoid a great deal of the impurities.

Must be free from projecting parts which could "hang up."

Must have a certain and easy method of getting under the coal and getting out from under the coal, even in the limited space.

Must be designed on the "continuous cutting" principle.

Must have a sure but flexible propulsion both forward and back.

Ability to cut from left to right or from right to left; not necessary, but very desirable.

Must be electrically driven.

OPERATION OF IRONCLAD CUTTER

It was logical that the Sullivan Machinery Co., with its pioneering experience in coal cutters of the "continuous cutting" principle and "Ironclad" construction should furnish a satisfactory machine. The machine supplied was a Sullivan Class CH-8 Ironclad Longwall Cutter.

The CH-8 shown at work in the accompanying photographs is 33 inches wide, 17⅜ inches high, has a cutter bar four feet long and weighs 4500 pounds. For moving along the roads, from one part of the mine to another, a truck is furnished on which the machine loads or unloads itself. In fact, power is made to do all the work, and jacking or barring is not needed.

Power for all operations is furnished by a 30-horsepower A. C. or D. C. motor, placed in the central section of the machine. Its horizontal rotor shaft drives the cutter chain through a clutch at the rear end of the machine. It also drives the feed gearing in the front end of the machine through an ingenious device known as the "friction."

One very interesting operation is "sumping" or getting the cutter bar under the coal. The cutter bar is pivoted in the back section and free to turn through 180 degrees in a horizontal plane, unless pinned in one of three positions, straight back or at 90 degrees on either side of the machine. To sump, the machine is pulled or backed alongside the face by its own power with the cutter bar straight behind. One end of the feed chain is attached by a hook to

Ironclad Machine at La Salle County Carbon Coal Company, approaching a road. Machine is advancing from left to right

Front end of Ironclad Longwall machine, advancing toward the reader, along the face. Face of coal is shown at the right, and pack wall or building at the left. This shows the confined space in which the machine operates

the cutter bar and the clutch thrown in. With the cutter chain traveling around the bar, the feed chain pulls the bar under the coal until a pin may be dropped through the frame into the cutter bar. This operation brings the cutter bar around to a right angle to and rigid with the machine body.

The feed chain is now unhooked from the cutter bar and the end is anchored in the coal at a point about 50 feet ahead of the machine and the machine is ready to cut coal. When it has cut up to the anchor, the machine pulls the chain through on fast feed, the anchor is moved ahead again and the machine is ready for another 50-foot cut.

The feed chain makes about three-fourths of a full wrap around a sprocket driven through the friction so that the machine climbs along the chain. The free end of the chain is allowed to pay out behind the machine, and no back anchor is set, as the machine is so balanced as to hold in against or "grip" the face. Throwing a lever engages either fast or slow feed, slow feed being used while cutting and fast feed for other operations. Various rates of feed are available to accommodate hard or soft cutting.

Mention was made of the friction. This device is operated by a lever at the front of the machine so arranged that when cutting or moving, the progress of the machine is instantly stopped without stopping the motor when any desired pull is brought on the feed chain. This pull is regulated to the strain necessary to cut the coal and when the cutter bits get dull or any dangerous strain begins to come onto the machine, the friction slips automatically, and no further cutting can be done until sharp bits are put in.

No track or skids are required for the machine to run on. It slides along the bottom and if it is necessary to cut high in the coal to avoid an obstruction, rocks, coal or props are thrown in front, and the machine rides over them and raises the cutter bar in the coal. Three men operate the machine, a runner in front, a shoveler behind, who keeps the cuttings away from the cutter chain, and a spragger who sprags up the coal to prevent its coming down before the loaders reach it. The spragger also sets the necessary props to make the place safe until the "pack walls" are put in.

WAGE SCALES

The performance of the first CH-8 was so satisfactory that many more were ordered, one company now operating 15. In establishing a scale of prices for machine work, the operators decided to do the brushing and "pack wall" building on company time in order to correct the unsatisfactory building, which had caused considerable expense under the contract of pick mining. It was thought that closer superintendence and the more desirable work resulting from it would reduce the expense of catching up bad work. This necessarily increased the proportion of company men under machine work, and the abnormal conditions of the last two years, when company men's wages have nearly doubled with only a slight increase for contract men, gave rise to a situation which could not be foreseen. The estimated differential in favor of the machine was wiped out and a differential adverse to the machine was brought about by this scale of prices. Fortunately the differential is based on the cost of coal at the face and through the open-minded efforts of the operators, close co-operation and interchange of data, and a study of the results of machine work, it was possible to continue the use of machines; and in fact more machines were ordered.

ADVANTAGES OF MACHINES

Of course increased capacity or rather normal capacity with depleted forces was possible. This meant the very life of some properties. Close study of the facts brought out many advantages. One

advantage we may mention was the ability to obtain and maintain a regular face line. under pick work and during the labor shortage an alarming situation had arisen from the inability to advance any but the best work. Certain so-called "hard places" were left far behind the good work. This played havoc with roof pressure and knocked out the best laid plans for longwalling. The machines were installed and put into the back work to catch it up, and where these back sections were short, two cuts were taken off these places to one in the advanced zones, and the faces are rapidly assuming a smooth curve. A regular face line is very necessary in Longwall work, and it could not have been accomplished without the Ironclads, except at the expense of production and at a prohibitive cost for deficiency work.

The top encountered is a soapstone and furnishes good material for "pack walls." It is taken down with picks and broken up by wedging in most cases, though explosives are required in some properties. The bands and balls of sulphur found in the cutting occur very irregularly and there is wide variation in the mines in the amount encountered. Height of coal varies considerably, but these features are so distributed that no one mine has all the advantages or disadvantages. Nature seems to have distributed her gifts fairly well.

Machine undercutting is paid for at from 12 to 14 cents per ton under the agreement. It is divided between the three men and allows them to make good wages. Power costs are less than one cent per ton. There have never been any races under test conditions, but we have observed one crew which cut 500 face feet in 8 hours.

Much credit for the success of the machines is due the executives of the coal companies for their whole-hearted cooperation with the Sullivan Machinery Company and their perseverance during the recent troublesome times.

BUY VICTORY BONDS

There are two reasons why readers of Mine and Quarry should make large investments in the Victory Liberty Loan, in April. The first is that the Government seriously needs the money to carry it past the worst of the war emergency. The second is that the fifth loan bonds are certain to become the most popular investment in the United States for the cash funds of business men and corporations. The very active market they will thus enjoy will drive them to a premium before any of the older Liberty issues.

Every contractor knows only too well that the peak-load of expense comes after the completion of the work. The final bills are the big bills. Uncle Sam is having the same experience in winding up his contract to drive kaiserism off the earth. Following the signing of the armistice, November bills aggregated more than those of any preceding month, December topped November, and January came within a few thousands of reaching the December peak. February has shown a considerable and gratifying reduction.

The fourth Liberty loan paid off the floating indebtedness then existent and carried the Government into December. Since then the nation has been borrowing $300,000,000 a week from the banks to meet the final bills. By the time the fifth loan drive opens the Government will owe in this way close to six billions. The Victory bond cash will refund and distribute this debt and will furnish operating cash for the Treasury until the money raised under the belated 1918 revenue act begins to come in.

AIR-LIFT BOOSTS ARTESIAN WELL FLOW

By John Oliphant*

The City of Clinton, Iowa, is provided with water for domestic and public purposes by the Clinton Water Works Company, a private corporation of which Mr. W. L. Meeker is superintendent. The supply is secured from some half dozen wells, having a surface flow of limited volume. These are connected so as to flow into a surface reservoir or may be direct connected to mains by means of suction pumps.

Experience showed that when suction was resorted to the supply for the summer hot weather load or an extended fire demand was insufficient. Three of the wells were therefore connected with an air-lift system arranged to discharge into the reservoir, using the suction piping as a gravity flow line.

A suitable arrangement of valves is provided to permit this flow from the wells to the reservoir, while the service pumps draw their supply from the reservoir by suction. By this arrangement, the water supply was more than doubled from these three wells.

The photograph on this page shows one of the 8-inch wells which had a natural artesian flow of about 150 gallons per minute. When under suction from the pumps, the pull-down was 20 feet, increasing the flow to 500 gallons per minute. When this well was connected up for operation under the air-lift, its production was increased to 1035 gallons per minute, the pumping head being 50 feet below the surface. The other two wells, connected up in the same manner, showed a proportionate increase. The picture shows the 8-inch well being discharged by means of a tee at the surface for flushing and cleaning out. An umbrella head was afterwards placed on this well, permitting discharge into the cement basin, from which the water was conducted by the suction line to the reservoir by gravity.

These wells are handled by means of a Sullivan central type air-lift pump, suspended on a two-inch air line in the 8-inch casing. The air for operating the wells is supplied by a Sullivan straight-line simple steam and compound air compressor, class WB-2, size 14x16x10x16 inches, having a capacity of 558 cu. ft. of free air per minute. The installation was effected in a simple and economical manner, piping the air from the receiver to and into the wells. On ordinary service, the pumps secure sufficient supply by direct suction. When an increase is demanded by the summer domestic requirements or by fire, it is merely necessary to start the compressor, throw a few valves, and the supply from the wells is more than doubled.

* 122 South Michigan Avenue, Chicago, Ill.

Flushing a well at Clinton, Iowa (Sullivan Air-Lift)

DRILL SHARPENER SPEEDS UP SHIPBUILDING

By Letson Balliet, E. M. and C. E.*

When the United States entered the War in 1917, the writer tendered his services to the Government, abandoning temporarily his duties and practice as a mining and construction engineer. After waiting for a military assignment for a brief period, he entered the service of the Moore Ship Building Co. at Oakland, California, in the capacity of efficiency engineer in the construction end of the work.

Sullivan Drill Sharpener making bolt-heads at a Portland (Oregon) Shipyard

*Buckeye-Belmont Mines, Tonopah, Nevada.

One of the items that attracted the writer's attention was the time and labor consumed in making drift bolts, rivets, grab iron ends, ball stanchions, etc., by hand. The blacksmiths in making the drift bolts had to put button-heads on them. It required eight minutes for a blacksmith and a helper to make one bolt at a cost of 24 cents a bolt. "Why not do this work on a Sullivan Drill Sharpener?" A machine was secured for trial purposes, and shortly thereafter the blacksmith shop received an order for 3250 button-head bolts, 32 inches long, to be made out of one-inch rods.

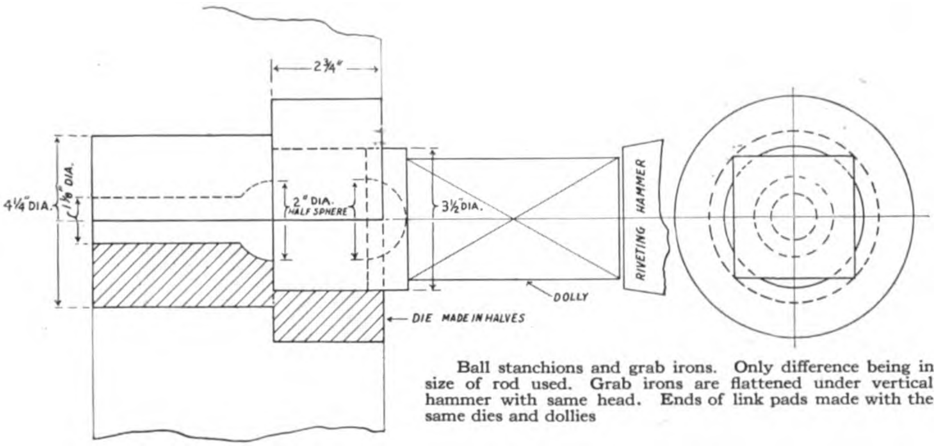
A pair of dies and a dolly were designed over night and made up, and the following day the bolts were turned out on the Sullivan sharpener at the rate of five per minute, over all time; the actual working time on each bolt being three and one-half seconds. The bolts were heated in an ordinary forge, and the manager, when he saw the sharpener in operation, said: "That machine could keep four fires busy."

This one job saved the company $732.00 over the old hand method, as well as accomplishing a considerable saving in time. Since then a special heating furnace has been erected near the machine on plans by Mr. Louis During, the superintendent of blacksmithing in the yard.

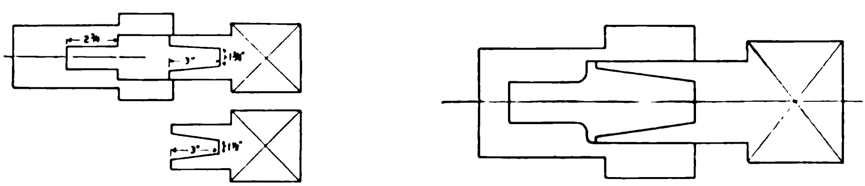
CLASSES OF WORK DONE

In addition to making the button-head bolts, the Sullivan sharpener has been used for a considerable variety of other special work. Dies and dollies have been designed for making the following ship fittings: ball stanchions, grab iron ends (wall ladders), link pads, rivet snaps and dies, countersunk bolts, etc. Mr. During's ingenuity is developing numerous special tools and dies for new uses.

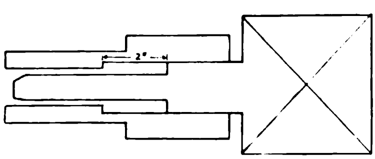
A great advantage possessed by the



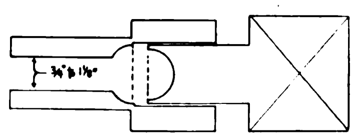
Ball stanchions and grab irons. Only difference being in size of rod used. Grab irons are flattened under vertical hammer with same head. Ends of link pads made with the same dies and dollies



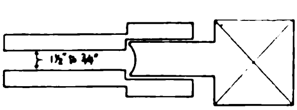
Die and dolly for making flush-rivet sets. The die is standard. All dollies work in same die making all sizes of flush sets



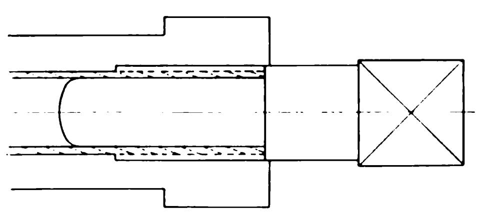
Upsetting boiler flues for Scotch marine boilers



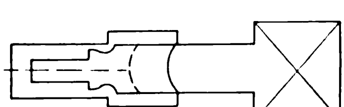
Another View of Ball Stanchion Set



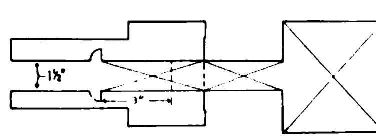
Die and Dolly for Upsetting Bolt Heads. Dies for all size rods. Head in dolly can be any size as any dolly can be used in any die



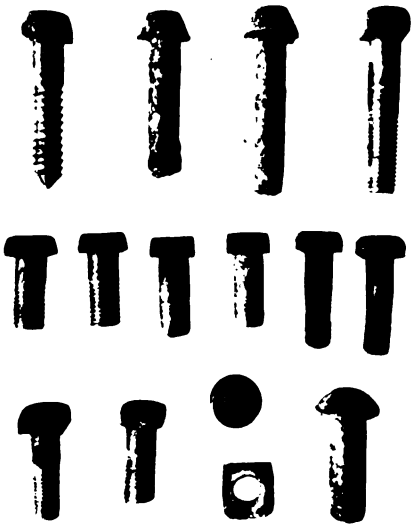
Die and Upsetting Dolly for Upsetting Boiler Stay Tubes



Die and dolly for making rivet snaps



Ends of gate stanchions. Square sockets. Round and tapered ends made in similar dies



Samples of work done at the Moore Shipbuilding Company Yard with the Sullivan Sharpener. Above, lag screw and bolt made from burned rivets; center, square head bolts remade from old ones on which the thread was stripped (read from right to left); below, disc cut in cold-punching steel ship plates, and nut made from it.

Sullivan sharpener over ordinary tools of the kind, lies in the fact that it comprises two hammers, so that any piece of metal which has been upset by the horizontal hammer may be immediately flattened or shaped by the vertical hammer with the same heat, resulting in a great saving of time.

UPSETTING BOILER TUBES

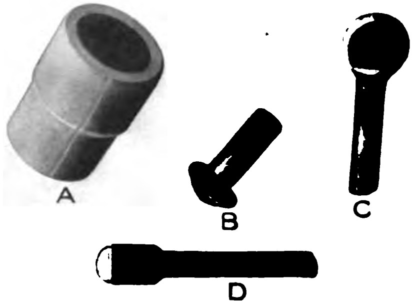
An important use of the upsetting hammer of the sharpener, lies in its adaptability to upsetting the ends of boiler tubes. In the manufacture of Scotch marine boilers it is necessary to upset the ends of the stay tubes sufficiently, so that a thread may be cut on them, while maintaining the original thickness of metal, and the same inside diameter. By means of special dies, designed by the writer, the ends of stay tubes are upset in the sharpener in from four to six seconds each, leaving an end which is perfectly smooth for threading. This novel use for a drill sharpener required a mandrel-dolly which was designed with a one-thirty-second inch taper on the mandrel, thus preventing the tube from shrinking itself on to the dolly. The ease with which the Sullivan sharpener upsets these tubes, under one hundred pounds air pressure, seems to suggest a new field for drill sharpeners, viz., in boiler shops.

The accompanying sketches show some of the dies and dollies which were designed by the writer and by Mr. During at the Moore Shipbuilding Yard and which can be employed or amplified as desired by other shipbuilding firms, or by any shop, in fact, which has special work of this kind to do. The photograph on page 1133 shows the end of the boiler stay tube, one of the ball stanchions, a button-head bolt, etc., made at Oakland. On page 1130 is an illustration showing the drill sharpener and a pile of bolts made on it.

USE OF HAMMER DRILLS

The driving of drift bolts and trenails on wooden boats and barges, previously done by men with sledges, was speeded up at the Moore Yard by the use of Sullivan DP-33 Hammer Drills, weighing thirty-eight pounds each and operated by one man.

Driving Sheeting with a Sullivan Hammer Drill



Work done on Sullivan Sharpener
A Upset End of Boiler Stay Tube, Ready for Threading
B Button Head Bolt
C Grab Iron End
D Ball Stanchion

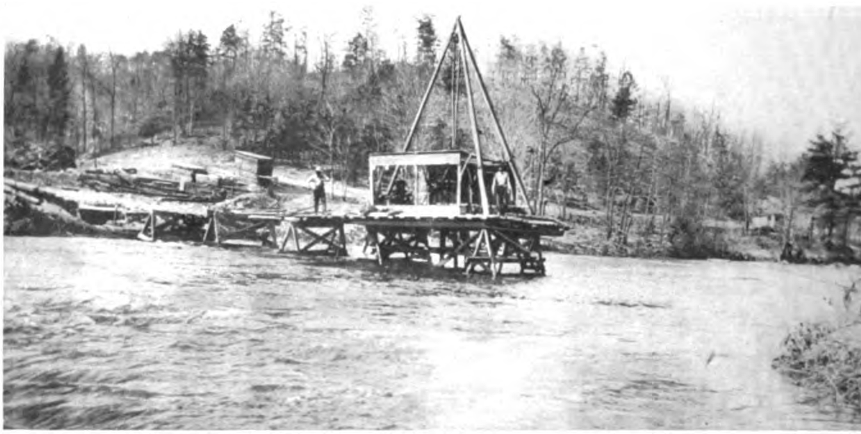
One drill drives as many bolts as sixteen men in a day's time. The drills also come in handy in construction and repair work.

The use of the drill sharpener for efficiency work in shipyards may well be copied or adapted at the mines. For example, track spikes cost from one to five cents each, depending on their size and the location of the mine. A one hundred pound keg will cost from seven to eight dollars almost anywhere. With the drill sharpener, a blacksmith's helper can, in a single shift, make several hundred pounds of spikes perfectly satisfactory for use out of old material, such as hanging bolts, scrap rod iron or old bolts, usually thrown away. Track bolts and machine and carriage bolts of all sizes can be made from scrap rods and old bolts of larger size.

With readily designed dies and dollies, the sharpener will make up from broken steel and short drills the finest kind of small tools for general mine use. The mine blacksmith shop should be able to pay its whole expense out of the scrap pile.

(The last paragraphs are quoted from the writer's letter to the *Salt Lake Mining Review* of recent date.)

Two Steam Rotators were recently used with good effect by the Crawford Mill Supply Company, at Winston-Salem, North Carolina, for making a rock cut for a sewer trench. The trench was about three feet wide and the rock cut was 400 feet long, ranging from three to twelve feet in depth. Hand drilling, which was started on this work, proved slow and expensive and two Sullivan Steam Tube Rotators were purchased as a substitute. With these, holes three to four feet deep were put in, three to five feet apart. Sixty per cent dynamite was employed, the holes being filled about two-thirds full and the balance tamped with clay. The rock was hard and broken, making a rather difficult drilling proposition, and the steam pressure was low for rapid work. Nevertheless the contractors report that excavation with the drills cost only about one-fifth of the cost of drilling by hand.



Sullivan Diamond Drilling Outfit on the Tallula River, Georgia, boring at site of Burton Dam

DIAMOND DRILLS PICK DAM LOCATION

By Fred Stanaway

The Georgia Railway and Power Company now has under way the construction of a dam on the Tallula River at Burton, Ga., to provide power for a new hydroelectric plant, which is to supply energy for operating numerous factories, cotton-mills and traction lines in that part of the South.

Several sites adjacent to Burton, Ga., were tentatively selected for the new dam. The Sullivan Machinery Company of Chicago was employed to conduct test borings with its diamond drill on these different sites, to determine which of them was best adapted geologically to sustain the structure of the dam safely and at least expense.

Holes were bored by the drilling crew on the river banks and also in the bed of the stream, the drill being mounted on a timber trestle or a frame work for this purpose. The Tallula River at this point is shallow, ranging in depth from three to six feet at different points and at different stages of water.

The site known as No. 1 was first drilled and was abandoned after the hole and cores removed indicated that the formation on the river bank was not sufficiently solid to sustain the required water resistance. This formation consisted of shattered granite with weathered mica seams, likely to permit leakage and ultimate failure of the dam, if built at that point.

The drilling crew then proceeded to the second proposed site, about one-half mile up the river from No. 1. The out-croppings at this place appeared favorable, but borings on both banks showed that the formation here also was badly weathered, and in addition cavities were encountered after penetrating 50 feet of solid rock. In one hole the drill broke into a water course containing sand and pebbles, evidently deposited there by the river at some earlier time, although the present course of the stream is 200 feet from the location of the drill hole.

The drill and outfit were then moved a quarter of a mile down the stream from the first site. Here the outcrop appeared less favorable, but drilling revealed the fact that the formation was much more

solid and reliable. More holes were put in at regular intervals along the line of the proposed dam, being staggered across the site 25 feet apart. The total length of the line was 1,200 feet. The cores obtained from these borings proved the formation to be firm and solid without cavities or weathered strata. The surface of the rock was weathered to a depth of from 5 to 12 feet, but below that point the rock was sound and not shattered.

At sites 1 and 2, 35 holes in all were drilled with the diamond prospecting machine, ranging in depth from 50 to 120 feet, or about 2,000 feet of drilling in all. At site 3, which was the location finally selected for the dam, 66 holes were drilled, amounting to 3,412 feet of boring. About seven months were required for the work. Two drills were used, a Sullivan Bravo hand power rig, operated by belt from a gasoline engine and a Sullivan Badger machine of somewhat greater capacity on the deeper holes; this latter being operated by steam from a portable boiler.

The cores removed by these two drills were $\frac{15}{16}$th of an inch in diameter. The photographs show the character of the cribbing or trestle work, employed for mounting the drills in the river bed. Timbers were cut 16 feet long, slotted at each end, and pinned together, forming a V-shaped frame. Four or more sets were pinned together on the river bank with compartments in each corner, which

Diamond Drill selecting Burton Dam Site

were loaded with stone, after the cribbing was floated to the location of the drilling. The cribbing was set in place by means of a block and tackle fastened to a running sheave on a cable stretched across the river and anchored on either bank, about 50 feet upstream, from the line on which the drilling was to be conducted.

HEAVY DRILLING AT SACRAMENTO HILL

By Robert T. Banks, E. M.*

Systematic prospect drilling on Sacramento Hill, by the Copper Queen Branch of the Phelps Dodge Corporation, has developed approximately fifteen million tons of copper ore averaging better than one and one-half per cent of copper, and Bisbee, for many years one of the world's greatest copper camps, is soon to assume fresh laurels and will take its place among the "porphyry" producers.

*Mills Bldg., El Paso, Tex.

The ore developed is in two bodies, which have been named the east and the west ore bodies, and are separated by a comparatively barren strip of ground from 400 to 500 feet wide. The west ore body, which will be mined first, is accurately defined and will produce something over six million tons of ore. Drilling is still in progress on the east ore body, but sufficient has been done to date to insure a

Sacramento Hill looking north. Bisbee in canyon to the left

Sacramento Hill, showing arrangement of benches

production in excess of ten million tons. The west ore body, considered as a unit, will average better than two per cent copper, which is considerably higher than the average of the working "porphyry" deposits in the United States. The east ore body will run lower in copper content.

Sacramento Hill, the most prominent physical and geological feature of the Warren district, is a massive granite porphyry stock. Around its southern base in a semi-circle are grouped the mines of the Copper Queen and the Calumet and Arizona companies. From these mines over 4000 tons of ore are hoisted daily and are shipped to the smelters at Douglas.

The hill itself, with reference to the newly developed ore bodies, is a capping of overburden or waste, and a large part of the hill must be removed before mining operations can begin. The stripping operations over the west ore body, which are well under way, as is shown in the photographs, require the removal of approximately 15,000,000 tons of waste before a pound of ore can be mined. About two years will be required to complete the stripping operations which will lay bare the west ore body. This in itself is an exceedingly expensive undertaking. Every ton of waste is solid rock, which must be drilled and shot with powder before it becomes accessible for the steam shovels.

BENCH METHOD OF EXCAVATION

To carry on the stripping operations the hill has been laid off in benches as is shown in the photograph on page 1136. The lower or "machine shop" bench is immediately over the ore body. The three benches above this are 60 feet apart vertically. Each bench has its own steam shovel and trackage system, and the broken waste is placed on 20-ton side dump standard gauge cars. Because of the heavy grades required to reach the dumping grounds four cars constitute a train, which is drawn by an oil-burning locomotive.

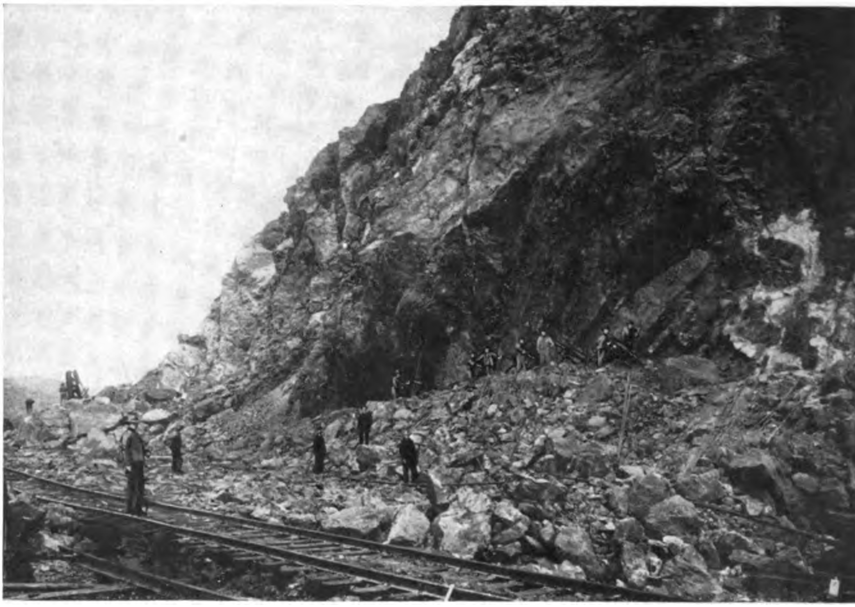
Both churn drills and tripod drills are used in the rock breaking operations. From the bench above, 60-foot churn drill holes are put down; and these are first "sprung," then loaded and fired by electricity. To relieve the churn drill holes, 22-foot flat holes are drilled at the base of the bench by tripod drills. These also are "sprung" first and then loaded with two to three boxes of dynamite each. Because of extremely variable rock conditions no set rule can be applied to the spacing of churn drill holes. It is simply a case of "the harder the ground, the closer the holes and the heavier the charge."

HYSPEED DRILLS FOR TOE-HOLES

Several types of drills were tried out on the "toe-hole" work, including the heavy piston machines and the hammer type with independent rotation. The Sullivan "Hyspeed" piston drill with 3¼-inch cylinder diameter was selected for this work and is now used exclusively. These drills have seen extremely hard service. Time and again they have been buried under slides of hundreds of tons of rock, only to be straightened out in the repair shop and sent back for more work. Not a single Sullivan drill has failed to return to the job.

The air for the Sullivan piston drills is supplied from the Copper Queen power plant. Each machine's crew consists of a Mexican runner and helper. The "toe-holes" are spaced approximately six feet apart in hard ground and from eight to fifteen feet apart in the medium and broken ground. All holes are drilled nearly flat with just enough down pitch to permit water to run into the hole. Solid steel with a cross bit is used and blow pipes are employed to help clean the holes.

In many places extremely difficult drilling ground has been encountered, the rock being unusually hard and at the same time "fitchery and cavey." Consequently many holes, after reaching a depth of 15 feet or more, caved behind the bit, making recovery difficult. The extremely variable



Drilling operations on upper bench

Six Sullivan "Hyspeed" Drills on "toe-holes," Sacramento Hill.

ground has made the keeping of accurate drilling records impracticable, but in hard ground one 22-foot hole is considered a shift's work for a runner and helper. When drilling conditions are reasonably good a crew will drill two of the 22-foot holes in a shift. All machines are mounted on heavy tripods, and as the ground is usually rough and covered with boulders considerable time is consumed in setting up and moving.

NEW MILLSITE BEING CLEARED

Coincident with the stripping operations on Sacramento Hill the Copper Queen concentrator department is preparing a millsite for the erection of a 4000-ton concentrator, the work being so planned that the concentrator will be finished about the time the stripping operations over the west ore body are completed. Unless the delivery of structural steel for the mill building is held up by unforeseen conditions, the mill will be producing copper concentrates about the 1st of January, 1920. A small test mill has been in operation for some time and very satisfactory results have been obtained, using the latest practices in gravity concentration and flotation.

An excellent millsite has been selected on the southern slope of the Mule Mountains facing the international border, about two miles south of the Sacramento Hill operations and one-half mile southwest of the town of Warren. Ample tailings storage is provided for on the sloping mesa to the south.

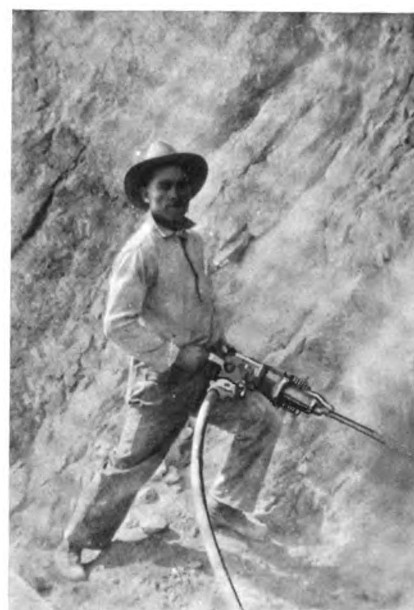
EXCAVATING WITH ROTATORS

In preparing the terraces for the mill floors extremely hard close grained quartzite and limestone were encountered almost at the surface. At no place on the millsite is the wash more than a few feet thick. Sullivan "DP-33" Hollow Piston Rotators were selected for drilling operations, the air being supplied through a five-inch air line from the Copper Queen power plant. Even in the hands of inexperienced Mexican operators the upkeep on these machines has been exceedingly small and a runner will drill a hundred feet of hole per shift in the hardest quartzite. Sixteen of the Sullivan rotators have been in constant use since the work started. Hollow hexagon rotator steel with a cross bit is used and holes four to six feet deep are the rule. The drill steel is sharpened at the Copper Queen central shop.

The push button on the Sullivan Rotator, which locks the valve and permits live air to rush through the steel with the hammer stationary, is especially effective in this ground. A "stuck" drill is rarely encountered.

BLASTING PRACTICE

The management has been exceptionally careful in regard to the safety of the work-



Sullivan Rotator drilling in quartzite on terrace floor

Excavation for Concentrator

men on the millsite and has found it good practice to fire from 200 to 300 holes at a time, giving the workmen ample opportunity to get out of range of flying rock. It is worthy of note that only one man has been injured on the works and this injury consisted of a slight scalp cut. This is probably a record, inasmuch as the work on the millsite has been in progress more than six months and not less than 125 men are employed.

Stripping operations on Sacramento Hill and the work on the concentrator are in capable hands, as is customary in the Phelps Dodge organization. To these officials acknowledgment is tendered for their courtesy and assistance in securing the photographs and the above information.

ROTATORS MAKE SHAFT RECORD

A local record was made in shaft sinking at the Rachel Coal Company's mine at Broomfield, W. Va., in 1917. The shaft is 370 feet in depth to the bottom of the Pittsburgh No. 8 seam, which here attains a thickness of 8 feet. At a depth of 252 feet the bottom of the Sewickley seam was reached. This was found to have a thickness of 5 feet. The Sewickley and Pittsburgh beds are separated in this shaft by .110 feet of fireclay, limestone, sand-rock and various slates. This shaft is for air and is 12 feet in diameter.

Ground was broken for this shaft on June 11, 1917, and the first car of coal was loaded on September 1, 1917—a fine record. Nine Sullivan "DP 33" Rotator hammer drills were used in sinking the shaft and the management—E. F. Miller general manager, and J. C. Edwards, superintendent—states that the work could not have been completed as quickly except for the use of the Rotators. The average number of men working per shift was seven, three shifts being worked per day—all company work. Ventilation was effected by a 4-foot Robinson fan, the air being carried down the shaft in a 12 x 15-inch tongued-and-grooved wooden compartment. Forty-five feet of the shaft was concreted; five-foot section wooden forms were used. The concreting was completed with the original forms, on which there were no repairs.—*Coal Age.*

MAJOR BLACKINTON WINS D. S. C.

Major Geo. W. Blackinton, formerly office manager at Denver for the Sullivan Machinery Company, has been awarded the distinguished service cross by the United States War Department, according to recent advices from Washington. The official citation follows:

"Major Geo. W. Blackinton, 353d Infantry. For extraordinary heroism in action near Xammes, France, September 12–13, 1918. Having moved his battalion to an advanced position, in accordance with orders, Major Blackinton found himself without support on either flank and no supporting machine guns or artillery, two kilometers in advance of our main front line. In spite of his perilous situation this officer, with the utmost coolness and good judgment, set to work intrenching and consolidating the position determined to hold it at all costs, though his battalion was subjected to artillery and machine-gun fire and was threatened by counter attack by the enemy in force. Home address, Mrs. W. J. Blackinton, mother, 205 W. Ninth St., Flint, Michigan."

Gen. Hall awarding the Distinguished Service Cross to Major Blackinton at Prüm, Germany.

SULLIVAN GOLD STARS

One additional gold star has been placed on the Sullivan Machinery Company's service flag at its Claremont, New Hampshire, Works. Six men in all, employes of this company, have thus given the maximum service to their country.

Private Arthur J. Baribeau, 152d Depot Brigade, 12th Company, 4th Platoon, died of pneumonia at Camp Upton, New York, September 29th. Private Baribeau was 29 years old and had entered the service only a week before his death. He was buried with military honors at his former home in Berlin, New Hampshire, where his mother and several brothers and sisters reside. Another brother is in the Canadian Army. Baribeau had been, before the war, a member of the Home Guard in Berlin.

Private Daniel Hooper, Company K, 309th Infantry, was killed in action, November 1st, 1918. He entered the National Army, April 26th, 1918, being sent to Camp Dix, and from that point overseas about the middle of May. No further information has been received in regard to the action in which he lost his life. He had been in the employ of this company for four years, in the Production Department.

LIEUT. HOY CITED

Second Lieut. Austin Y. Hoy, Royal Garrison Artillery (English), received mention in dispatches to the British War Office from Sir Douglas Haig, Commander-in-Chief, of the British Army in France. The citation was in connection with the campaign of last Spring, at the time of the great German offensive.

Lieut. Hoy received his demobilization orders January 13th and is at present in the United States for a rest, and in connection with business matters.

Corp. H. Stuart Brock
62d Co., 16th Battalion,
Camp Dix, N. J.

Private Daniel Hooper
Co. K 309th Infantry, A. E. F., killed in action November 1, 1918.

Private Eugene Menard
Co. D, 212th Eng., Camp Devens, Mass.

Private Earl E. Willard
Co. E, 315th Ammunition Train, A. E. F., Morbach, Germany.

Major Geo. W. Blackinton, D. S. C.
353d Inf., A. E. F.

Corp. Nelson C. Bowles
39th Co., 10th Depot Brigade, Camp Devens, Mass.

Private Leslie A. Currier
Co. E, S. A. T. C., Durham, N. H.

Private Arthur J. Baribeau
152d Depot Brigade, Camp Upton, N. Y., died September 29, 1918.

Private Frank C. Skinner
Co. B., 2nd Battalion, Edgewood Arsenal, Md.

Several of the Sullivan Engineering and Sales Staff have been discharged from military service, and are again "going over the top" in their pre-war undertakings.

R. D. Willets (Second Lt. Ordnance Dept., New York City) has been appointed assistant sales manager of the New York City Sales Office.

Edwin T. Hall is again attached to the Salt Lake City Office. He enlisted in June, 1918, and after attending the U. S. Training Detachment at the University of Utah was assigned to Camp Jackson, where he was made an Acting Top Sergeant; and later attended the Field Artillery Officers' Training Camp at Camp Taylor, Kentucky, from which he received his discharge, November 30th.

M. J. Small is again attached to the San Francisco sales office, after qualifying for a commission as Second Lieutenant, at the Reserve Officers' Training School at Camp Mead, where he had been assigned for overseas duty on an Evacuation Hospital Staff.

Frederick W. Copeland (Second Lieutenant, Battery E, 333d F. A., A. E. F.) was discharged from the service in January and has been appointed Manager of the Foreign Trade Department of this Company with headquarters at Chicago.

Sidney F. Greeley (Captain, Battery B, 333d F. A., A. E. F.) after his discharge in January resumed his old position as assistant advertising manager at Chicago, and associate editor of MINE AND QUARRY.

R. S. Weiner has resumed his duties as sales engineer with the El Paso, Texas, branch office. Mr. Weiner, after serving as 1st Sergeant 340th F. A. at Camp Funston from Oct. 1, 1917 to May 1918, attended the Engineer Officers' Training Camp at Camp Humphrey, Va., and was commissioned 2d Lieutenant. At Camp Lee, Va., he was placed in charge of dock construction, going in October to Camp Forest, Ga., where he joined the 125th Engineers, a special dock construction regiment, of which he was Adjutant until his discharge, early in January.

Thirty-two Claremont employes have been discharged from military service and have returned to their former positions (March 1st). Ten employes of the Chicago Works have also resumed their civilian tasks after receiving their honorable discharge.

First Lt. S. A. Benson, (A. E. F.) Chicago Works, who has been an artillery instructor at Fort Sill, Oklahoma, received his discharge about two months ago, and is taking the Sales Engineering Course at Chicago.

John H. Emrick (First Lieutenant Coast Artillery Anti-Air Craft A. E. F.) has been assigned, following his discharge, as sales engineer attached to the Chicago office.

Henry C. O'Brien (Lieutenant U. S. Air Service, Northern Bombing Squadron A. E. F.) has returned to duty with the Boston office.

Harold L. Browne (U. S. Air Service, Instructor in Aeronautics, etc.) has received his discharge and is attached to the Duluth office with headquarters at Houghton, Michigan.

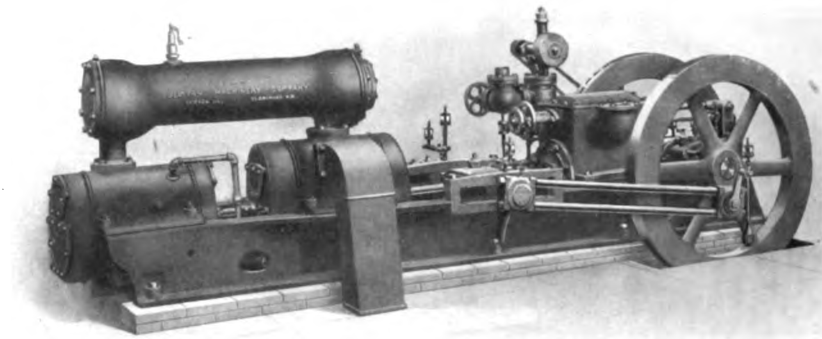
Eugene M. Clare received his discharge as Corporal, after five months, three at Camp Jackson and two months at Camp Sevier, Greenville, South Carolina, and for the past three months has been at his old work in the Chicago Order Department.

M. J. Pontius, formerly attached to the Chicago office, received his commission as Ensign, U. S. Navy, in January and will remain in the service for the present.

First Lieut. Charles B. Officer, who has returned to his civilian duties at Claremont, served with distinction on the staff of a general officer of the United States Heavy Artillery in France.

Robert H. Officer, who went to France, as first class sergeant in the Gas Regiment, was in action many times, was gassed, but is back at Claremont, as well as ever.

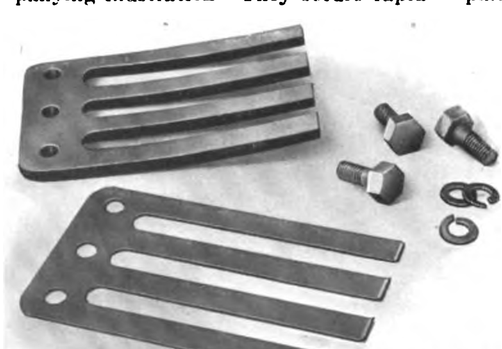
SULLIVAN STRAIGHT LINE COMPRESSOR WITH PLATE VALVES



Sullivan Improved Straight Line Air Compressor, "WB-3," with two-stage air cylinders and "finger" valves

During the past year a radical improvement has been made in the design of the Sullivan Straight Line Steam-driven Two-stage Air Compressor, which will be of interest to contractors and engineers. This consists in substituting for the semi-rotary or Corliss mechanically driven air inlet valves, formerly applied on these machines, the new type of Sullivan plate valves.

These valves, which are similar in design to those in successful use the past three years on Sullivan Angle-compound Compressors, are shown by the accompanying illustration. They secure rapidity of action, wide port opening, with minimum wire drawing effect, a reduction in motive power, and fewer moving parts. They are accessible for inspection or removal, strong and durable, and require no care or attendance. Excellent volumetric efficiency is secured, the factors of loss from clearance and leakage in this design being comparatively low.



Finger Valves, "WB-3" Compressors

The Sullivan finger valve is of a distinctive grid form, shaped like a group of thin flat fingers or blades, and made from special sheet spring steel. These valves are bolted at one end only to a steel guard plate, the other end being free. This guard plate is curved to form a rest for the entire length of each blade, when it is bent or lifted by the incoming or out going air. In lifting, under air pressure, the fingers exercise a rolling or rocking action against the guard, opening first at their outer ends. In closing the fingers roll back to their seats, the fixed end closing first and the free, outer points last. The end rolling action is free from bodily lift that would produce a hammering or slapping

effect. The idea for these valves was obtained by the Sullivan engineers from the familiar band saw, which is continually bending and straightening again around its pulleys. As the radius of curve of the valve guard plates is much longer than that of the pulleys, the durability of this form of valve, made of band saw steel or its equivalent, is obvious.

The valves seat over rectangular slots or ports in the face of the cylinder heads. The inlet valves are situated in the upper half of the head, and the discharge valves, which are of the same design, in the lower half.

An improved and simplified steam valve mechanism, controlled by a Meyer adjustable cut-off, and a new and improved pressure and steam regulator, form other desirable features in these Sullivan "WB-3" Compressors as now furnished. In the older, mechanical valve design, they have been popular for a dozen or fifteen years past on account of their excellent efficiency, simplicity and strength and the reliable character of the service rendered. They are built in capacities ranging from four hundred to nine hundred and fifty cubic feet per minute.

Inside of Cylinder Head showing finger valves

Outside of Cylinder Head with valve cover plates removed

TAKE THE VICTORY LOAN!

Readers of MINE AND QUARRY do not have to be reminded that their own future prosperity is tied up with the success of the loan. If the banks have to take the new bonds, a very large part — say 40 per cent — of the funds actually available for general industrial credit accommodation will be tied up. Contractors and mine owners know what it means to face a credit limitation. Business will be held back and unemployment will result. As regards the market for the new bonds among business corporations there can be no question. All the terms of the new issue will favor the use of the new security as an investment for the cash funds of business concerns. The third loan 4¼s, by reason of having only ten years to run, are even now selling at a one point premium over the second and fourth loan 4¼s, which have a much longer maturity. The fifth loan bonds will be of very short date and will everywhere be classed as a cash asset. This means a very broad and active market.

AN IDEAL SHOP FOR SHARPENING DRILL STEEL

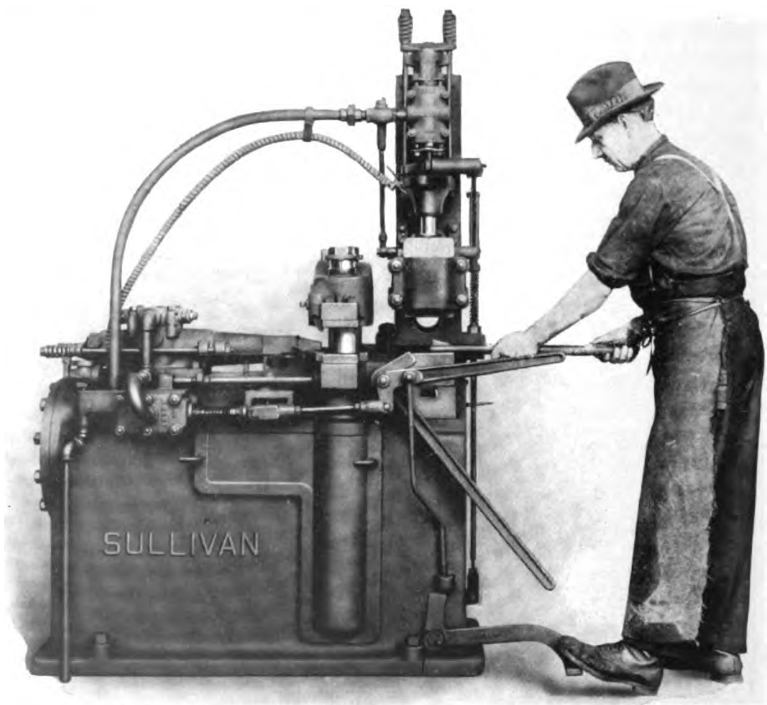
By George H. Gilman*

[This article, which was originally printed in Engineering and Mining Journal, was begun in the November, 1918, issue of Mine and Quarry. Copies of that issue may be obtained upon request. —*Editor.*]

THE DRILL STEEL SHARPENING MACHINE

By far the most essential requisite of a drill-steel plant is the machine for forging the bit and shank ends of the drill steel. There are few apparently unimportant items of expense that are likely to assume more serious proportions than the wasting of time by men, caused by failure of the machine to turn out the finished product in a condition that meets the requirements of the plant. Correct sizing and shaping of rock-drill steel are just as essential to efficient mining as the efficiency of the drill itself and, therefore, a machine sharpener should be adopted that conforms with these requirements and in addition produces the bit and shank end in the best possible condition to be tempered.

It is a well-known fact that the "standing-up" quality of a piece of steel when forged to a finished shape by hammering, under light rapid percussive blows, is superior to that secured by any other known method. For this reason a drill sharpening machine answering this requirement is desirable. It should be equipped with means supplementary to the main forging dies for gaging the various sizes of bits mechanically, within close limits, and for punching out the



Sullivan All-Hammer Drill Sharpener

*Chief Engineer, Pneumatic Drill and Channeler Department, Claremont, N. H.

axial hole of the steel at both the bit and shank ends. In construction it should be strong enough to withstand without undue wear or breakage the severe service to which it is subjected and all control levers should be interlocked in order to insure the various operations being performed in proper sequence and with a minimum of danger both with respect to the operator and the piece being worked upon.

For the storage of dies, dollies and other drill-sharpener appurtenances the cabinet shown by Fig. 7 will answer the requirements satisfactorily. Placed at a convenient distance with respect to the drill sharpener and between the used-drill-steel table and the anvil, the heights of which correspond, it serves also as a support for the drill-steel bar stock when being cut to proper length preparatory to forging and also as a straightening bed for bent steel by virtue of the three bars of iron rail with which the top of the cabinet is equipped.

A floor grinder, preferably direct-motor-driven and equipped with two 18x3-in. corundum or carborundum wheels, should be placed at the left of the drill sharpener where it will be readily accessible to the operator. The function of the wheel adjacent to the sharpener is that of squaring off the ends and redressing drill shanks, while the wheel opposite, which should be preferably of somewhat finer grain, may be employed for refacing dies and dollies and other general grinding. The speed of the grinder when driven by a 5-hp. motor should be 1150 r.p.m. When grinding drill shanks the steel may be supported by a hook suspended from an overhead trolley having its track mounted in alignment with the grinder wheel and at right angles to the grinder shaft. Such a support is described in the *Journal* of Feb. 10, 1917, by James E. O'Rourke.[1]

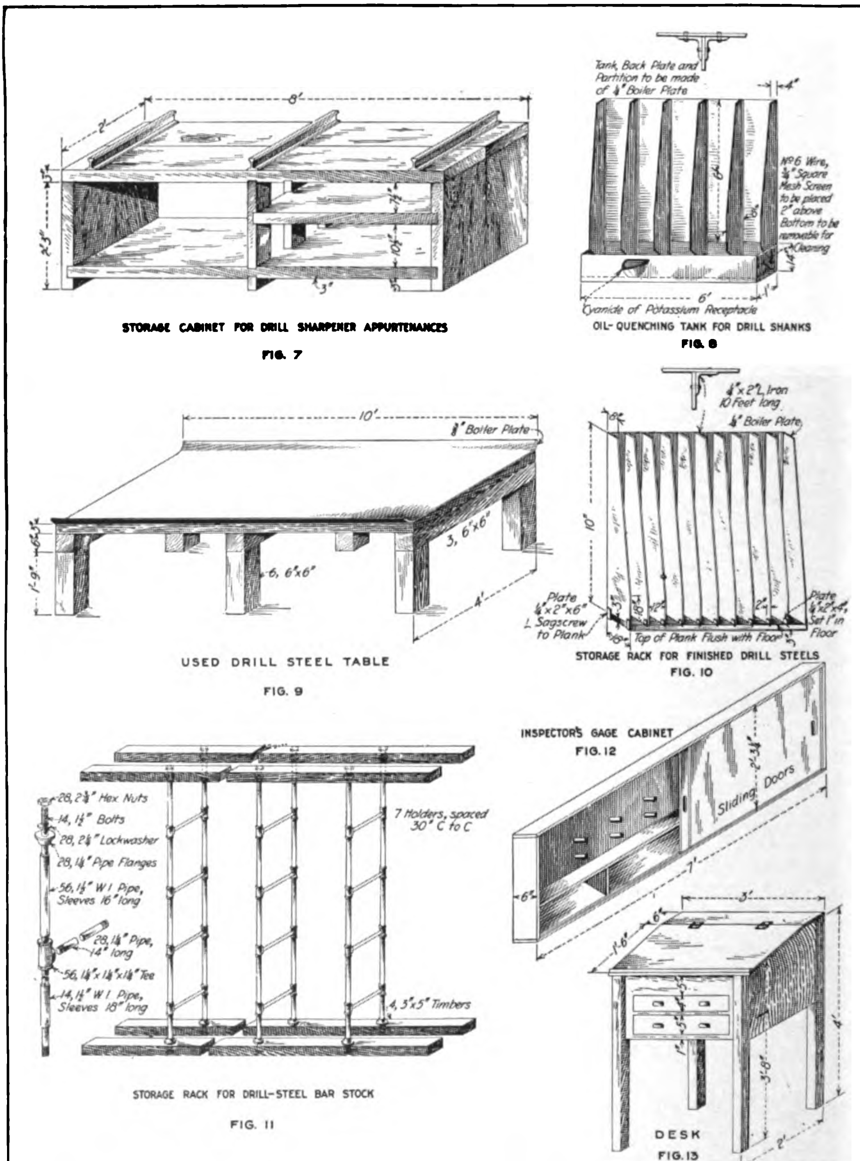
The heat treatment of rock-drill steel is a factor which determines success, as applied to the excavation of rock, to as great a degree as the heat treatment that is accorded the various parts that enter into the construction of the drill itself and, when the requirements of the work are once fixed, it is of the utmost importance that the temper of each piece be the same. This result may only be secured by reducing to a minimum the personal equation. While many expert steel workers are able to determine by experiment the required hardening heat and the cooling method for steel of various chemical compositions, the human potential is influenced by the physical condition of the man, and in order to carry the operation of tempering beyond the point of human influence, machinery must be employed as a substitute.

For the requirements of a drill-steel plant of the size and type described herein, the tempering machine for the bit end of the steel as developed[2] by the Homestake Mining Co. is perhaps the most satisfactory. This machine, preferably motor driven as shown in the plan view, Fig. 1, is placed at a point adjacent both to the tempering furnace and to the main water supply, and is so positioned and equipped with guide hangers that the drill steel, when discharged, falls on the inspection rack where it is accessible for inspection. Back of the tempering machine and adjacent to the heating furnace, where it is accessible to the compartment car when placed near the dead end of the track, is the oil-quenching compartment tank shown in Fig. 8 with its supplementary receptacle for cyanide of potassium. This is employed only for tempering the shank end of the bar in the manner described in my article on "Drill Steel and Drill Bits for Metal Mining," published in the *Engineering*[3]

[1] "Operating a Drill Sharpening Shop," by James E. O'Rourke, "Eng. and Min. Journ.," Feb. 10, 1917.

[2] "Eng. and Min. Journ.," May 12, 1917.

[3] Mine and Quarry for Aug., 1917, Feb., 1918 and July, 1918.



Figs. 7 to 13. Accessory Equipment for Ideal Shop for Sharpening Steel

and Mining Journal of May 12, 1917. Both tanks are preferably of steel construction and it is recommended that the inner surfaces be coated with an acid-resisting paint as insurance against oxidation.

STORAGE RACKS AND TABLES

The used-drill-steel table of the type shown by Fig. 9, on which the used drill steel is deposited from the division car, provides a means for facilitating preliminary inspection. If bent or plugged steel is found, the defects are corrected by using the straightening and cleaning facilities, provided on the top of the drill-sharpener cabinet before the steel is loaded into the compartment car preparatory to heating for forging. In the case of broken steel it is cut to length, piled on the floor at some convenient point until a sufficient quantity has accumulated, when, as regards the necessary forging and tempering operations, it is treated as new steel.

For the storage of finished drill steel a rack, shown by Fig. 10, and placed adjacent to the inspection sorting rack, is recommended. This rack should have compartments preferably made of boiler plate, and should be equipped with a base plank of hard wood to protect the floor and to insure the bit ends of the finished steel against chipping. The various compartments serve to accommodate the different lengths and types of drill steel that may be employed. From its position, as shown by Fig. 1, the finished drill steel may, when required, be transported directly to the division car or to the inspection rack for bundling.

A convenient and inexpensive storage rack for drill-steel bar stock is shown by Fig. 11. This may be constructed by any experienced mechanic or blacksmith from standard materials usually sold by hardware stores in every mine and quarry district. Preferably the base timbers are embedded in the concrete floor while the top stringers may be fastened by any means convenient to the girders of the building. From its position opposite the supplementary doorway in the east end of the building (Fig. 1), where it is conveniently situated for receiving the material, the various sections and sizes of drill-steel bar stock may be readily removed and carried to the anvil and straightening bed for cutting to the desired length for forging.

INSPECTION RACK FOR FINISHED DRILL STEEL

For inspecting the finished drill steel a rack, the details of which are shown by Fig. 4 will be found convenient, as it permits the inspector to walk between the rails and thereby facilitates the work of inspecting and sorting. After inspection the steel bars may be easily rolled to the edge near the track, from which they can be loaded directly into the division car, or transferred to the finished drill-steel rack as desired. As shown by the general plan, the inspector's gauge cabinet, Fig. 12, is mounted on the timbers at the operating end of the rack where it is conveniently accessible. In this cabinet, which is equipped with sliding doors, wood pins and shelves, means are provided for storing the necessary gauges and measuring devices.

SANITARY TOILET-ROOM FACILITIES

Applications of the principles of scientific management have demonstrated the importance of providing sanitary facilities, not only as applied to the surface equipment of the mine but to the underground workings. The wide-awake mine manager is striving to narrow the gulf between himself and his workmen by the giving of happiness and the meting out of justice. Health is the foundation of happiness and it is on this theory that industrial manufacturers have for years recognized the economic advantage of substituting clean, light and well ventilated buildings for the unsanitary shops of the past.

A workman who finds pleasure in his work and his environment usually prides himself in producing a satisfactory product. It is on this theory that toilet facilities are recommended as applied to

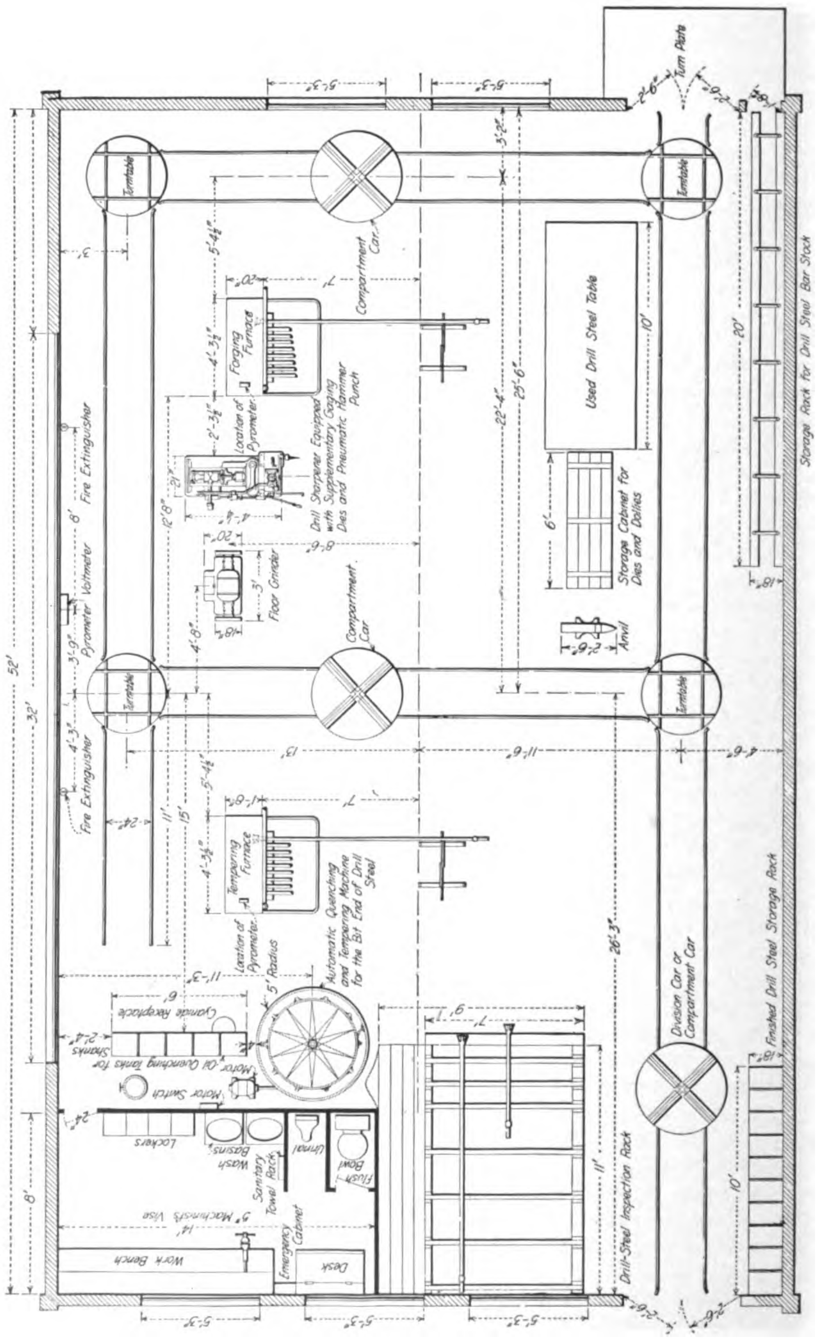


Fig. 1. Floor Plan of Ideal Shop for Sharpening Steel

the mine drill-steel shop. The toilet room illustrated in the plan view is in a corner of the building where the space it occupies is not required for other equipment. It is adjacent to that part of the plant where running water is required for the tempering machine so that the branch length of water piping necessary for the flush bowl, urinal and wash basin is reduced to a minimum. These accessories are placed near the inner wall of the toilet room in preference to the outer wall of the building, to minimize the liability of freezing in cold weather. Furthermore, this arrangement permits the placing of the work bench and the foreman's desk, Fig. 13, where the light from outside may be used to the best advantage. Double-deck lockers, one for each workman, an emergency Red Cross cabinet and a sanitary paper towel rack, in addition to the sanitary drinking fountain, placed in the main shop adjacent to the toilet room, complete the sanitary equipment.

COMPRESSED-AIR SUPPLY IN SHOP

Compressed air is necessarily used for operating the drill sharpener and, in the absence of a blower, for operating the furnaces. Another desirable use for the air is to facilitate the work of inspecting the hole in hollow drill steel and to assist in cleaning out plugged steel. For this latter purpose the air is conducted by a pipe line to a point adjacent to both the used-drill-steel table and the inspection rack, Fig. 1A, from which it may be conducted to the work by a 12-ft. length of ⅝-in. plain, pneumatic, air hose equipped with a Davies blowgun[1] (the invention of Thomas Davies, head blacksmith of the United Verde Copper Co.). In the use of this feature the operator, by merely pressing the nozzle of the gun against the mouth of the hole in the drill steel, causes a valve to be automatically opened which allows a blast of air under line pressure to be blown through the opening. The act of removing the nozzle of the gun from the end of the steel causes the push throttle to be closed automatically. If preferable for the final inspection of the drill steel, water under pressure instead of compressed air may be employed at the inspection rack, in which case the nozzle of the gun is preferably equipped with a backing flange and a soft rubber gasket, which, when compressed against the end of the steel shank, provides a seal and prevents undue leakage. In Fig. 1A subfloor conduits for the compressed-air piping are shown.

[1] Drill Sharpening Method at the United Verde Mine, Arizona," by Frank Richards, *Engineering News*, Feb. 1, 1917.

HEATING, LIGHTING AND VENTILATING THE SHOP

For heating the building in cold weather a four-coil radiator composed of 2-in. wrought pipe, extending from the west entrance and along the west, north and east walls to the east entrance, will answer requirements satisfactorily except for extremely cold climates, in which additional coils may be required. Live or exhaust steam may be employed for the purpose but in either case the precaution of providing suitable drains in the system should be taken to insure against freezing.

The lighting and ventilating facilities of the plant are items that should receive due consideration. In Fig. 1 is shown the location and size of the windows recommended for a plant of the type herein described, on the assumption that the building is placed on a line running east and west and the normal position of the operator faces in a northerly direction to avoid the direct rays of the sun falling upon the front side of the furnace and drill sharpener. A steel sash pivoted at the sides is recommended for the windows and may be operated by means of a rocker shaft procurable from the manufacturers of such apparatus. The windows at the ends of the building may, if desired, be composed of four rows of sash, while the sill of the window in the north side of the

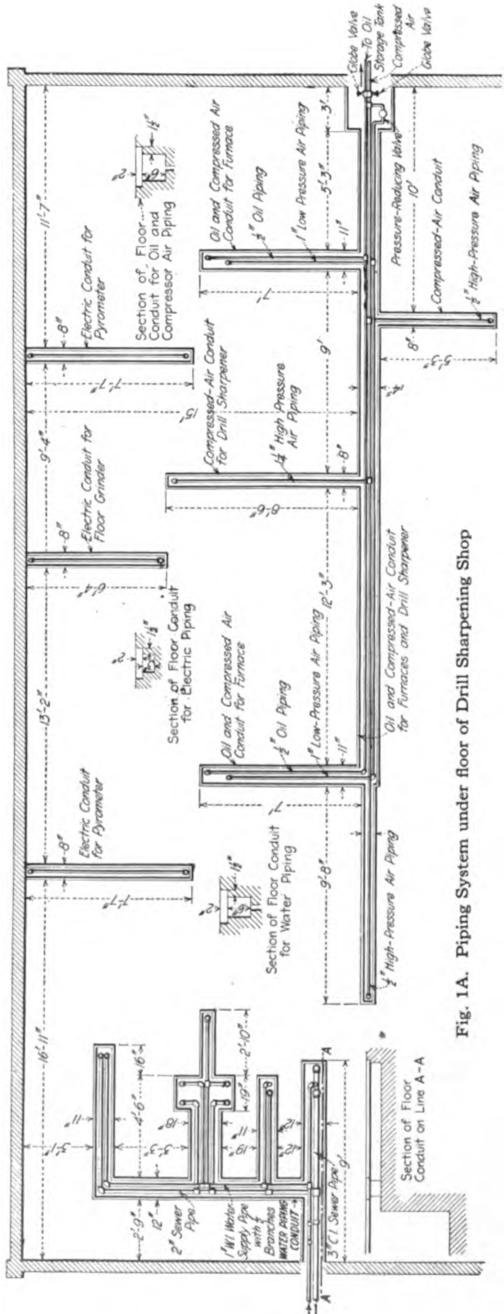


Fig. 1A. Piping System under floor of Drill Sharpening Shop

building should preferably be mounted at least 7 ft. above the floor and composed of eight panels, in a single row, operated by one gear from the rocker shaft. From such construction, a fair degree of natural light and ventilation is secured. For exhausting the gases from the heating furnaces, suspended hoods, adjustable vertically and equipped with telescope flues extending through the roof of the building, should be provided.

Artificial light sufficient to meet the requirements of the main shop may be secured from two 500-watt Mazda lamps with reflectors, supported from the roof on a center line through the building, one of which should be placed at a point slightly to the left of the drill sharpener, while the other should be slightly to the left of the tempering furnace. One 60-watt Mazda lamp suspended by an extension cord directly over the desk in the toilet room will be found ample for the purpose.

FLOOR PREFERABLY OF CONCRETE

The floor of the shop should preferably be of concrete, poured after the wood base plates of the various fixtures, including ties for the track system, are placed in position. Conduits for all subfloor piping should be provided (see Fig. 1A) of such size and shape that there is ample clearance for the pipe and its fittings, with provision for a covering with wood plank. The advantage of this construction is obvious as it provides a means for making the system readily accessible in case the pipe should become plugged or broken through accident. If desirable, a wood floor pad made

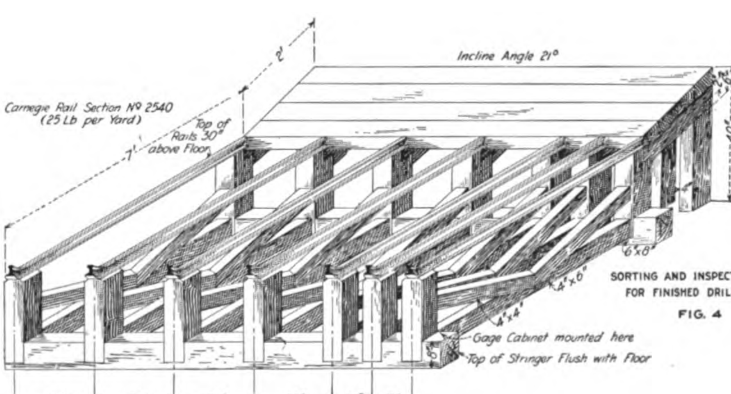
of 2-in. planks may be embedded in the concrete at various points repeatedly covered by the operators. This provides for a certain amount of resiliency which will be found advantageous.

INCREASING CAPACITY OF SHOP

By adding 24 ft. to the east end of the building and the installation of an extra drill-sharpening machine, heating furnace, grinder, cabinet for drill sharpener appurtenances, and track with one turntable, the output of the plant may again be increased approximately 50% by the addition of two operators. The ultimate capacity of the plant will then correspond to the requirements of all but a few of the largest users of rock drills in this country having a central drill-steel plant.

PROCEDURE TO ADOPT FOR MAKING NEW STEEL

Remove the drill-steel bar from the bar-stock rack and place it on the top of the drill-sharpener cabinet with the end of the bar to be cut off supported by the anvil. Nick the bar at the desired point, using a chisel and sledge and break to length, leaving temporarily the pieces to be worked upon on the drill-steel table. When a sufficient quantity of pieces are available, place in the heating furnace, handling the steel in rotation by inserting a new piece when one is removed, after having attained the required degree of heat for forging. Form the shank in the drill sharpener, using the grinder and pneumatic punch, if necessary, after which place in compartment car, shank end down. When the forging operation is completed, turn the compartment car one-half way around, place the shank end of the bar in the tempering furnace, handling the steel in rotation as before and, when the shank has been heated to the required degree for tempering, remove from the furnace, dip the tip end in the cyanide of potassium and then plunge the heated end in the oil vat, allowing it to remain in the oil until cool. Now remove the steel from the oil vat and place it in the compartment car shank-end down. Run the car to its position adjacent to the forging furnace, remove the bar and insert the blank end in the furnace, handling it in rotation as before. Form the bit to the required gage diameter for the particular length of the piece being worked, after which place it in the compartment car at the left of the furnace. When the forging operation of the bit end is completed, turn the compartment car halfway around, place the steel in the tempering furnace, handling it in rotation as before and, when the required degree of heat is attained, quickly insert it in the



SORTING AND INSPECTION RACK FOR FINISHED DRILL STEEL

FIG. 4

Sullivan Drill Sharpener equipped with Sullivan Hammer Punch for punching out hollow steel

bath of the tempering machine. After the steel has reached the inspection rack, inspect each piece carefully, place the pieces that pass inspection in the finished-drill-steel storage rack or in the division car and rework the defective pieces if any are found.

PROCEDURE IN REWORKING USED DRILL STEEL

After the used drill steel is transported by means of the division car from the shaft, or receiving platform outside of the building, it is deposited on the used-drill-steel table, where it is subjected to a preliminary inspection. If bent or plugged drill steels are found they are straightened and cleaned out by the use of the anvil in conjunction with the straightening bed on top of the sharpening-machine cabinet, after which they are sorted and placed in the compartment car. If a shank is found broken to such an extent that reforging and tempering are warranted, the steel is discarded temporarily and placed in position convenient for reforging when a sufficient quantity has accumulated to warrant the operation, in which case the procedure will be the same as that required for shanking new drill steel.

In the case of shanks that merely require regrinding to put them into proper working condition the steels are placed in the compartment car (shank end down), which, after being loaded, is pushed to a point adjacent to the grinder, where such steels are removed and redressed, after which they are placed in the car (bit end down) and the whole is transported to a point adjacent to the forging furnace where the procedure for sharpening the bit is the same as that required for the bit end of new drill steel. After the final inspection they are again bundled, if such be the practice, loaded into the division car and transported to the shaft, or loading platform, for distribution.

If desirable, a lessening of the distance covered by the operator, while removing the steels from the furnace, forging and grinding prior to depositing them in the compartment car, can be made. The grinder, drill sharpener and forging furnace may be grouped more closely together and the sharpener and furnace set at an angle of 70° with relation to the longitudinal line of the building by swinging the working end of the sharpener and forging furnace in a westerly direction from the position shown in Figs. 1 and 1A. The oil-quenching tank for drill shanks may also be set at an angle of 60° with relation to the tempering furnace by swinging the end of the tank nearest the north wall in an easterly direction.

AUTHOR'S SUPPLEMENTARY REMARKS

In the original presentation of the foregoing article it was thought best to exclude the names of the manufacturers or builders of the various parts of the equipment recommended. But in this reprint which has been produced in a form convenient for filing and which will be placed in the

hands of a great many of those men actively engaged in the production and upkeep of rock drill steel, whose interest in the matter may promote an investigation as to the make of features of the suggested equipment, the following details are given.

The mechanical drill sharpener described in the article is that manufactured by the Sullivan Machinery Company of Chicago. As there stated, it employs a hammer blow for upsetting and swaging in combination with the supplementary gaging dies for the final shaping of the bit within narrow limits and its pneumatic hammer punch for opening the hole in both the bit and shank end of hollow drill steel.

The type of heating furnace described is based on the outcome of a series of experiments that have been conducted to determine desirable qualifications of such a furnace as applied to the heating of the present standard shapes of drill steel. To my knowledge there is not a furnace on the market at the present time embodying in one unit all the qualifications that I have enumerated. The practicability of each of these has been proven, which fact warrants my recommendation for its adoption. The Ajax furnace, at present manufactured by T. H. Proske, and the Case furnace, manufactured by the Denver Fire Clay Company, both of Denver, Colorado, embody many of the desirable features enumerated. The floor grinder described is manufactured by the United States Electrical Tool Co., Cincinnati, Ohio.

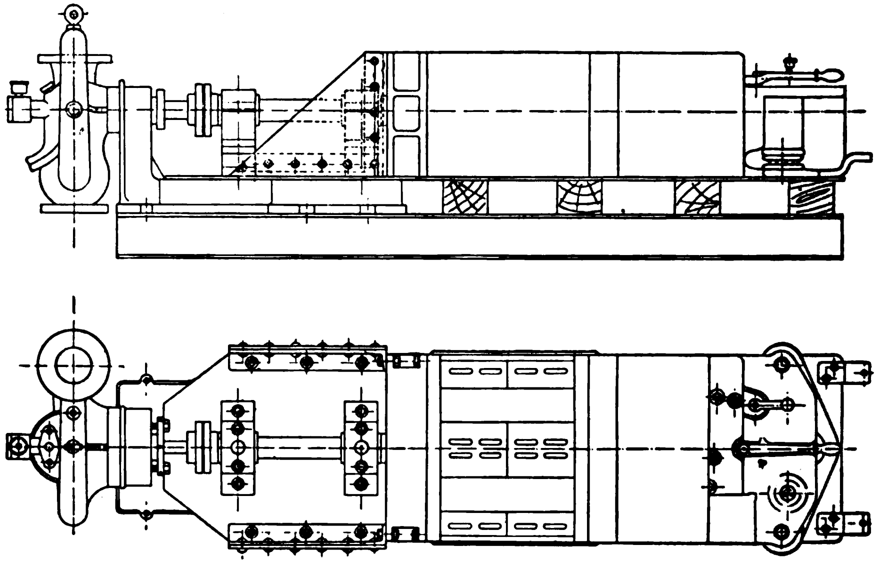
COAL CUTTER USED AS PUMP

By Lt. Austin Y. Hoy*

A novel use of compressed air coal cutters was reported some time ago from a Colliery in South Wales, and the emergency work done in this case may be interesting to readers of Mine and Quarry. The coal cutter was a Sullivan Turbinair Longwall Ironclad Mining Machine, owned by the Powell-Duffryn Steam Coal Company, Ltd., at Aberdare, S. W. Late in May, 1916, water broke into their Aberaman pit to a very serious extent. It was impossible to use their electrically driven pumps to get rid of this water, due to the presence in the pit of an explosive mixture of gas and air. Mr. George Hann, Chief Engineer, conceived the idea of saving the Colliery by attaching some of his Turbinair Ironclads to centrifugal pumps. The sketch on page 1156 shows how this was done. It was, no doubt, a most ingenious solution, because of the difficulties of connecting centrifugal pumps to a reciprocating engine by belt in an emergency. Two six-inch and one seven-inch centrifugal pumps were operated in this manner. One six-inch pump was driven continuously for eighteen days and the other for fourteen days, while a seven-inch pump operated for six to eight days. The six-inch pumps operated against a head of 20 feet and the 7-inch pump against 50 feet. The estimated quantity of water lifted was 25,000 gallons per hour. Compressed air at 50 pounds pressure at the coal cutters motors was available. Mr. Hann's description of the method of connecting up the coal cutters is as follows:

"We allowed the bottom sole plate where the coal cutter motor is fixed on to remain and took away the center pin and bevel wheel off the frame and put two girders about 6 x 5 underneath. We used packing pieces for the motor feet to stand on. This allowed the engine part and shaft of the motor to line up with the centrifugal pump and we only had to put in a few bolt holes to enable us to connect the coal cutter base to the pump base.

*Royal Garrison Artillery.



Centrifugal Pump driven by a Sullivan Turbinair Coal Cutter

The coupling was of the ordinary cast iron flange type with pins and rubber washers. To get over the danger of sparking on the bearings we put in a long oil bearing of anti-friction metal. There was a certain amount of explosive mixture in the pit and we were afraid that if the bearings ran warm, there might be some sparking. We used these coal cutters motors and turbo pumps where it was too dangerous to use electrically driven pumps. The discharge valves of the pumps were open full."

NEW BULLETINS

The Sullivan Drill Sharpener.— Sullivan Machinery Co., Chicago, Ill.; Bulletin 72-C. 24 pages; 6 x 9 in. The Sullivan All-Hammer Drill Sharpener is fully described and illustrated in this bulletin.

Small, Belt-Driven Air Compressors.— Sullivan Machinery Co., Chicago, Ill. Bulletin 75-G. 12 pages; 6 x 9 in. This bulletin describes the Sullivan small, belt-driven air compressors, class WG-3, single stage, and class WH-3, two-stage. It is fully illustrated and contains tables of specifications and details.

Portable Mine-Car Air Compressors.— Sullivan Machinery Co., Chicago, Ill. Bulletin 75-I. 8 pages; 6 x 9 in. This bulletin describes the Sullivan motor-driven portable air compressors, class WK-2, mounted on a special truck for underground service. Illustrations and a table of details are given.

Sullivan WA-5 Air Compressor.— Sullivan Machinery Co., Chicago, Ill. Bulletin 75-D. 12 pages; 6 x 9 in. This bulletin gives a general description of the Sullivan single-stage, steam-driven, straight-line, air compressors, class WA-5. A table of dimensions is also given.

Sullivan WB-3 Air Compressors.— Sullivan Machinery Co., Chicago, Ill. Bulletin 75-E. 12 pages; 6 x 9 in. This bulletin describes the Sullivan straight-line, simple steam and two-stage air compressors, class WB-3 with finger valves. It is fully illustrated and contains a table of dimensions.

A PLAIN DUTY TO OURSELVES

Venereal Diseases and the dishonorable wounds resulting from them incapacitated more than 200,000 men and boys of our National Army during the months intervening between mobilization and the signing of the armistice. One hundred millions of dollars and over 2,000,000 soldier days were lost to our military establishment at a time when *all* forces, financial as well as physical, were vitally needed to reinforce Pershing's men on the fighting line.

"Why did our military authorities tolerate such conditions?" you ask. They did not! Our American Expeditionary Force over there has been and is the cleanest army ever known in the world's history. Here is the crux of the problem. MORE THAN FIVE-SIXTHS OF THE VENEREAL CASES TREATED IN OUR NATIONAL ARMY WERE BROUGHT IN FROM CIVIL LIFE, contracted by the men before they were inducted into service. No one section of the country is responsible for this black record; cities, towns and hamlets in every part of the United States contributed their full quota to the venereal wards. This fact proves that every man and woman, every business and fraternal organization and all municipal authorities must take steps not so much to protect the general public from the soldier as the soldier from the surroundings he will encounter on his return to civil life.

During the past twenty months, the War Department and the United States Public Health Service evolved a program for combating this menace, a program already adopted by many of our most progressive towns, cities and states. The two most important features,— those which will, if properly carried on, destroy the venereal peril,— are education and legislation.

Civic organizations are taking measures to educate the executive and law enforcing officials of their community on the necessity for immediately and drastically suppressing prostitution. Business and professional men, through their Chambers of Commerce and Rotary Clubs, are working to eliminate vice and venereal disease. Women's clubs are taking their proper place in the van of the clean national army. Our greatest industries, such as the Emergency Fleet Corporation, Dupont Powder Company, Phelps-Dodge Corporation, General Electric Company and hundreds of others are telling their employees in plain language, the tremendous toll, in money and health, exacted by this plague.

The fight must hereafter be waged most relentlessly by civilians in *their own* communities. On them lies the burden of making their home surroundings clean and fit to receive the men who have fought and bled in their behalf.

The powerful equipment of the United States Public Health Service is being used for a vigorous continuance of the campaign now and after demobilization. Already its aid has been offered and accepted in many communities and will increase in effectiveness as new ones avail themselves of its service. A standardized program for industries, large or small, has been compiled. The financial outlay for this material is but slight, and full details will be sent for the asking.

If you are an employer of men or women and will use the standardized program for fighting this national menace, write to:

THE WAR DEPARTMENT
Commission on Training Camp Activities,
Social Hygiene Division
105 West 40th Street,
New York City

If you want information, or will help in the permanent campaign of education and law enforcement, write to

THE UNITED STATES PUBLIC HEALTH SERVICE
Division of Venereal Diseases,
228 First Street, N. W.
Washington, D. C.

MINE AND QUARRY

REG. U. S. PAT. OFF.

VOL. XI, No. 3 JULY, 1919 WHOLE No. 38

Claremont (New Hampshire Works of Sullivan Machinery Company, 1919

FIFTY YEARS OF ROCK CUTTING TOOLS

A MODEL ILLINOIS COAL MINE

NEW SULLIVAN STOPERS

PUBLISHED BY THE SULLIVAN MACHINERY CO. CHICAGO

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MINE AND QVARRY

REG. U. S. PAT. OFF.

VOL. XI, No. 3 JULY, 1919 WHOLE No. 38

A Quarterly Bulletin of News for Superintendents, Managers, Engineers and Contractors.

Published by the Advertising Department of the Sullivan Machinery Company

Address all Communications to MINE AND QUARRY, 122 South Michigan Ave., Chicago. Sent to any address upon request.

Readers are requested to notify MINE AND QUARRY of any correction or change in address

It is eight months since the armistice was signed. The treaty of peace has been completed and the league of nations is preparing to undertake its work. A very large part of the armed forces of the United States is at home and discharged from service, and the remainder, except for the regular army and navy, will soon be released. Readjustments of industrial relations, in this country, at least, are being made with relative smoothness. Governmental war time restrictions are rapidly being lifted, and federal operation of wires and rails will soon be a thing of the past.

The stimulating effect of these changes is being felt in all branches of business. Roads and bridges and buildings and industrial plants are being built and planned in terms of millions. There is an oil boom in progress in Texas, Oklahoma and Kansas; surplus stocks of metal are rapidly being worked off, and mining activity is increasing in proportion.

This is a time for optimism, for planning and executing new and large projects. Home markets and foreign fields are seeking our products. It is a wonderful opportunity for American industry to go forward fast and surely.

"Let's Go!"

GEORGE ELMER WOLCOTT

The Sullivan Machinery Company deeply regrets to announce the death on May 10th, after a protracted illness, of Mr. George Elmer Wolcott, New England Sales Manager. Mr. Wolcott had been identified with this company since 1888. He was born in Claremont, New Hampshire in 1868. After attaining a position of responsibility and trust, which he held for a number of years at the Claremont Works of the Company, he was appointed New England Sales Manager in 1905 (with headquarters at Boston, since 1911). The officers of the Sullivan Machinery Company take this opportunity of paying tribute to the qualities of loyalty, honesty, strength of purpose, and to the sympathetic sp rit and kindl ness wh ch marked the character of their former associate and friend.

Fifty years ago, a Yankee inventor joined forces with the proprietor of a Yankee machine shop, up in the New Hampshire Hills, to begin a new industry, dedicated to the aid of human enterprize in winning the wealth that lies in the earth's rocky crust.

Who the founders of this industry were, what beginnings they made, and how they and their successors have established a great business, based on ingenuity, energy and integrity, will be told briefly in this and succeeding issues of MINE AND QUARRY.

Before 1860, water wheels made by the founder of this company were carried on Llama-back up to mines in the Andes. Today modern Sullivan mining machinery travels the same route and performs a more varied service. The article by Mr. Miller on a Bolivian Tin Mine will afford interesting reading to North American mining men.

The Sullivan Machine Company, Claremont, N. H., in 1869

FIFTY YEARS OF ROCK CUTTING TOOLS

George B. Upham*

The establishment of the machine business in Claremont, N. H., which later became the Sullivan Machinery Company, was due to the enterprise of James Phineas Upham, who made a beginning there shortly after his graduation from Dartmouth College in 1850. How he came to live in Claremont may be told in a few words, involving an interesting and little realized fact in American history.

In the later years of the eighteenth century the Upper Connecticut river valley was to the settled communities of Southern New England what the middle west became to all New England half a century later. Enterprising people went there, "to grow up with the country." Mr. Upham's father, George Baxter Upham, after graduation at Harvard in 1789, saddled his horse, rode north from Brookfield, Mass., settled at Claremont and there began the practice of the law, which he continued throughout Western New Hampshire for forty years. He founded the first bank in Claremont and was elected to Congress for several terms, riding to and from Washington on horseback. He died in 1848. His son, after graduation from Dartmouth, returned to Claremont and bought lands bordering on the Connecticut River which are still occupied by his descendants. Although without mechanical training Mr. Upham was always intensely interested in machinery, especially in new and useful improvements.

A little machine shop with a small foundry was then in existence on a part of the present site of the Sullivan Machinery Co. in Claremont. Mr. Upham bought it in 1851. It was at first carried on

*233 Bay Way, Boston, Mass.

in the name of Mr. Upham's bookkeeper and known as "D. A. Clay & Co." When additions to the buildings and machinery had been made, in 1854, it was dignified by the name "Claremont Machine Works." Among its products advertised were "Engine lathes of 4 sizes and the latest patterns," "Iron Planers of a new and desirable style," "Paper Mill Machines" and "Circular Saw Mills, the best in use." The Tuttle Water Wheel was another product. This water wheel was superseded by the "Tyler Turbine Water Wheel," invented by John Tyler, a resident of Claremont, and was extensively manufactured by the Claremont Machine Works and its successors for a third of a century.

In 1856 this wheel was exhibited at the Crystal Palace in New York and received the highest prize medal awarded to water wheels. More than three thousand were manufactured by the Claremont Machine Works and its successors, some made in sections to be carried up into the Andes and other mountainous districts on muleback.

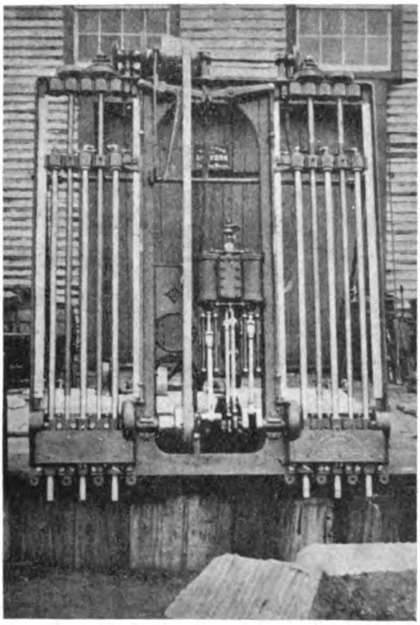
The Claremont Machine Works at about the same time also received the highest premiums awarded at the Crystal Palace in New York for engine lathes and planers.

As early as 1854 the "Works" were fitted out with "A Large Chucking Lathe having a swing of 6 ft. 9 in. and adapted to the heaviest work," with "Boring and Screw Cutting Machines, and Gear Cutters for all kinds of machinery." All work sent out was warranted. Thus early did the predecessor of the Sullivan Machinery Co., establish the principle of standing behind its work. At about this early period the business was recorded as having an invested capital of $15,000 and employing thirty men, probably an understatement of both.

About 1860 Mr. Upham, continuing to be the sole owner, changed the name to J. P. Upham & Co. During the sixties the manufacture of the Tyler Water Wheel was continued in large numbers; thousands of water wheel regulators were built, and lines of agricultural machinery were added, among which were the "Clipper Mowing Machine;" the "Lufkin Side Hill Plough;" one of the early, improved reversible ploughs; the "Colby Cultivator and Harrow," a predecessor of the disc harrow now in common use; and the "Hunt Sulky Plough," believed to have been the first of that type.

On an afternoon in May, 1868, Mr. Upham was pruning apple trees near the highway, leading up the Connecticut River valley and known in colonial days as the "Great Road." Two strangers driving in a light "buggy" stopped, inquired where Mr. Upham lived and on learning that Mr. Upham was speaking to them, hitched their horse to a tree and talked with him for an hour or more; they on the outside, he on the inside of the moss

James Phineas Upham, Predecessor and Founder of the Sullivan Machine Company



The first Diamond Channeler, 1869

grown stone wall, a broad stone serving as a desk for the exhibition of sketches and for mathematical calculations. The strangers were Albert Ball and Roger W. Love from Windsor, Vermont, seven miles up the river. They brought with them sketches of a newly invented and patented diamond channeling machine for quarrying stone, especially marble. An agreement to build this machine was made then and there, and this interview over the old stone wall may be truly said to have been the inception of the Sullivan Machinery Company as an organization devoted especially to the construction of rock cutting and mining machinery.

Since the meeting of these three men resulted in the organization of a corporation and the establishment of a business which has since become well known throughout the world, it seems worth while to relate the circumstances which brought the three together.

In 1863 an enterprising New Englander, Mr. E. G. Lamson, was engaged in the manufacture of machinery in Windsor. Among other products of Mr. Lamson's establishments were sewing machines and sewing machine needles, for which he required a small but extremely accurate engine lathe. Albert Ball, born at Boylston, Mass., in 1835, and at the time in question employed by L. W. Pond in Worcester, had built such a lathe for his own personal use.

Mr. Lamson, learning of this fact from a fellow passenger, straightway repaired to Worcester, found Mr. Ball and ordered two such lathes. Mr. Ball had been making fine screws for a fire-arm then manufactured by his employers. To see almost any piece of mechanism was sufficient to suggest to his mind an improvement. He constructed a combined repeating and single loading gun. Mr. Lamson saw it and then and there bought the patent rights, at the same time engaging Mr. Ball to go to Windsor to further develop his invention and to superintend the manufacture of the rifles.

In the Spring of 1866, Mr. Lamson became interested, from a fellow traveler, in the possibilities of improved stone channeling machines. He directed Mr. Ball to make working drawings for a machine of this type.

Roger Love, a young man whose father had invested some capital in Mr. Lamson's enterprise, saw the stone channeler, then under the cloud of an injunction, for patent interference, and conceived the idea of channeling stone by boring intersecting holes with diamond drills operated in gangs. Mr. Love was not a mechanic, so Mr. Ball, outside of working hours, draughted a machine developing the idea. Mr. Lamson heard of this and sharply reprimanded him. The resignations of both and the interview with Mr. Upham over the stone wall promptly followed. Thus were these three men brought together, and thus came into

existence the Sullivan Machine Company.

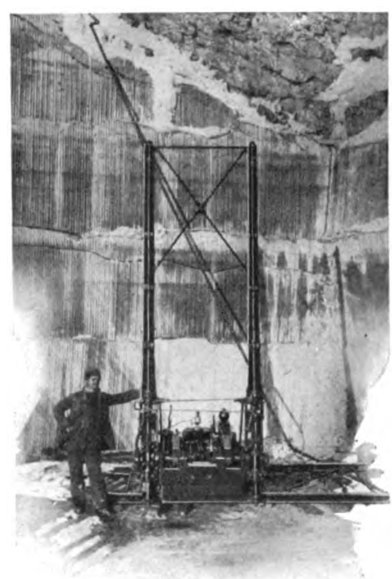
It is of interest to note the consequences of Mr. Ball's improvement in rifles. The U. S. Government contracted for two thousand of them, but about the time they were completed the Civil War ended. The Windsor Company then had five hundred rifles left on hand. A wide-awake German saw one of them in New York, bought the entire lot and shipped them to Prussia. The government of that belligerent autocracy immediately reproduced them, with some modifications, in enormous numbers. With this superior arm Prussia was then prepared to go out and steal something from her neighbors. She promptly did so. Defeating Austria and her allies, who had no repeating rifles, at the battle of Sadowa in July, 1866, she practically annexed not only Schleswig, Holstein and Hanover in the north, but also some half dozen South German states which had been the allies of Austria. Thus was the inventive genius of the man who was to be for nearly half a century chief mechanical engineer of the Sullivan Machinery Company unwittingly a cause of Prussia's military ascendancy. The Ball repeating rifle is an acknowledged progenitor of the Winchester and other leading repeating rifles. Mr. Ball was also, in 1863, the inventor of the cartridge greasing machine which, with little change, is everywhere in general use today.

Work was begun upon the diamond channeling machine as soon as the working drawings could be prepared. It was completed in August, 1868, operated upon blocks of marble on an outdoor platform where the shipping room of the factory is now, and first tried in the quarries of the Sutherland Falls Marble Co. (now Proctor, Vt.) in September, 1868.

On January 18, 1869, the Sullivan Machine Company was organized under New Hampshire laws. The name Sullivan was that of the county in which the business was carried on, which had been named for the intrepid General John Sullivan, who with General Stark had shared the principal honors of New Hampshire in the Revolution.

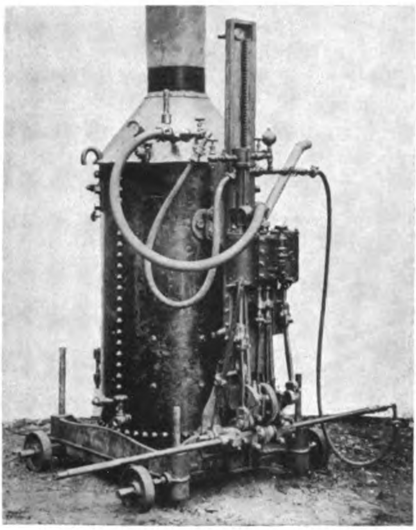
The incorporators were James P. Upham of Claremont, Roger W. Love and Albert Ball of Windsor, Horace T. Love and Edwin T. Rice of New York City. The purposes were "carrying on a General Foundry and Machine business, including the development of inventions and the holding and management of Patents relating to Machinery." The capital stock was fixed at $200,000.

At the first meeting held on February 6, 1869, the five incorporators were elected directors. James P. Upham was elected president, an office held by him for twenty-three years; Roger W. Love, Treasurer, and Albert Ball, Superintendent and Mechanical Engineer. Mr. Love and Mr. Ball came to reside in Claremont in the Spring of 1869.



Sullivan Diamond Channeler at work, and wall cut by it

In February, 1872, John Henry Elliot of Keene, N. H., who for years had been a personal friend of Mr. Upham, invested $50,000 in the business, taking unissued stock at par to that amount; he was immediately elected a director in place of Horace T. Love, and remained a director until his death in 1895.



Sullivan Diamond Gadder, with boiler, 1870 or 1871

The first diamond channeler, completed in August, 1868, was a six spindle, variable speed core drill, movable on a track with a gauging device to space the holes, and operative at any angle. It was soon found that the cores caused difficulty by breaking and jamming in the rods, and an obtuse-angle, conical, solid head was substituted for the annular head, with at first four, later two, holes for the escape of the water to clear the detritus. Black diamonds were then cheap, costing only $3.50 per carat. They now cost $100.00 per carat. About twelve diamonds were set in each head. They averaged about three-sixteenths of an inch in diameter, about nine-tenths of each diamond being embedded in the steel. At the periphery they projected slightly beyond the circumference of the head. This channeler made wall cuts at any desired angle, which no other machine was capable of doing.

The first channeler was never sold but used on contract work in Vermont marble quarries and for a time on red sandstone at Portland, Conn. The channeling price was at first $1.25 per square foot, later reduced to seventy-five cents. The second was sold to the Columbian Marble Co. and used in its quarries near Sutherland Falls, Vt. The third was sold to the owners of the old Prime Quarry at Brandon, Vt.

In 1871 the six spindle machine was superseded by the two-or-three-spindle channeler, which remained in use for many years until the high price of "carbon," black diamonds, proved prohibitive. The thousands of square feet of semicircular drill holes on the walls of stone and marble quarries in Vermont and other states attest the extensive use of the diamond channeling machines made by the Sullivan Machine Company.

The drills sank into the marble at the astonishing rate of eight to ten inches per minute when run at the usual speed of 800 to 1000 revolutions. A depth of one inch to a hundred revolutions could be depended upon in average marble.

These channelers were so far in advance of all other machines that they became indispensable and elicited the highest praise from many of the best known quarry men who wrote as follows: "The great labor saving machine of the age;" "Without it we cannot successfully compete with our rivals in the trade;" "Does work hitherto regarded as impossible to be done by machinery." In 1869 the company built its first "Gadder," a single spindle, solid head diamond drill, used for shallow holes beneath the marble block to split it from its bed. One machine accomplished more and better work than the hand labor of twenty men.

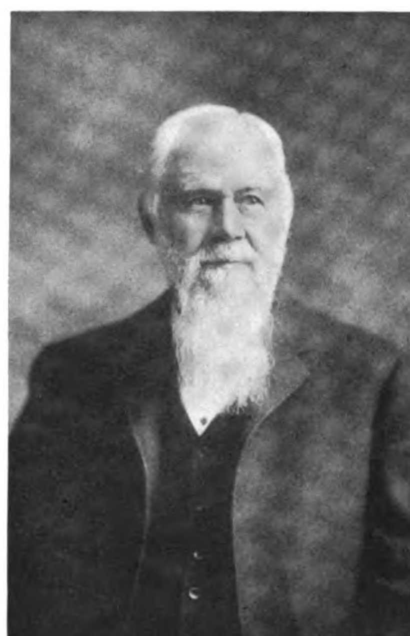
(This article will be continued in our

September issue with some account of early core drills for testing purposes, of early steel bit channelers and other products of the Sullivan Machine Company down to 1892.)

The Sullivan Machinery Company has appointed Mr. George H. Richey as New England Sales Manager to succeed Mr. George Elmer Wolcott, whose death is announced elsewhere. Mr. Richey has been associated with Mr. Wolcott as Sales Engineer in New England and Eastern Canada for several years past. Under Mr. Richey's direction the company hopes for a continuation of the pleasant business relations hitherto existing with its friends and customers. The Boston offices remain at 201 Devonshire Street as heretofore

ALBERT BALL, MECHANICAL ENGINEER

Mr. Albert Ball, for nearly half a century Chief Mechanical Engineer of the Sullivan Machinery Company, and some of whose exploits of invention are described in the historical sketch by Mr. George B. Upham, elsewhere in this issue, is one of the men who has made Yankee mechanical skill and ingenuity famous all over the world. His ancestors came to this country not long after the landing of the Pilgrims, and their hardy, self reliant stock is prominent throughout the pages of New England's early history. Mr. Ball was born in 1835, one of a family of six children. His older brother, Phineas, was Mayor of the City of Worcester in 1865, also served that City as Water Commissioner and City Engineer, and was prominent in the life of the community and state. Albert Ball's education began at five years, when he was sent to the district school, and ended in his sixteenth year with one term at the high school. At nineteen years of age, he entered the machinist's trade at Worcester, serving his time with the Wood & Light Company, afterwards working with Williams & Rich, and later for L. W. Pond. With Mr. Pond he had charge of the work of making planers, and it was in 1863 that he brought out his first invention, which was in repeating firearms. In the same year he invented and patented a polishing machine, the first machine made that was capable of polishing flat surfaces. While Mr. Ball was with the firm of Lamson, Goodnow and Yale at Windsor, Vermont, he invented and manufactured the first cartridge greasing machine, as a result of his visit to the Springfield, Massachusetts, Armory, on the contract for the Ball repeating rifles, which Mr. Lamson was making. Colonel Benton, who had charge of the Armory during the Civi. War, called



Albert Ball, Chief Mechanical Engineer of Sullivan Machinery Co. for nearly 50 years

Mr. Ball's attention to the lubrication of bullets. It had been found that cartridges used with the breech-loading rifles gathered dust and dirt on account of the grease placed on the outside of the bullets. Orders were issued that all breech-loading cartridges should have the grease on the inside of the shells, but the labor of filling the grooves in the bullets came to nearly as much as the cost of the bullets themselves. He asked Mr. Ball to devise some machinery by which the bullets could be cheaply lubricated.

Mr. Ball immediately worked out a device which he found would be successful and took drawings of it to Springfield. From this, at Colonel Benton's request, he made up a hand machine, which, under his expert direction, worked to perfection. Four power machines were immediately ordered for the different arsenals.

The bringing out of this machine was to Mr. Ball a source of greater satisfaction than the introduction of any other improvement he ever made, being as it was, a tribute from the United States Government to his inventive ability.

Similar bullet lubricating machines were afterwards sold to all the armories in this country and in Europe, and are in use by most of the cartridge manufacturers at the present time.

After his association with the Sullivan Machine Company in 1868, the full power of Mr. Ball's ability as an inventor was attained. Beginning in 1869 with the diamond channeler and gadder, his genius was wholly or in part responsible for the development of many important improvements in mining and quarrying machines. Among these are diamond core drills for mineral prospecting and test borings, of which he designed many types and sizes; direct acting steel channeling machines in numerous patterns, for quarries and public works; rock drills and drill mountings embodying distinctive features; gadder frames, quarry bars, mining columns and tripods; the early continuous cutting chain coal mining machines (with J. L. Mitchell), and the Sullivan direct acting air driven coal pick machine or board puncher, which achieved and held a wide popularity for many years.

In the early days, Mr. Ball also devised many less important machines, which were built at Claremont. One of these was a cloth measuring machine for use in dry goods stores. This was followed by the paper roving can for use in cotton mills; by the cop tubes for mule spinning, of which several millions were manufactured; by ring frames for spinning; by wood pulp grinding machines; by corn crackers and crushers, which are built to the present day; by wiring machines for inserting wire holders in toilet paper; presses for making asphalt paving blocks, and many other ingenious devices.

Mr. Ball was retired from his every-day duties with the company, which his efforts have done so much to build up, several years ago. In his new found and well deserved leisure, his active mind is still vigorous with the problem of doing things by machinery. One of the amusements he has devised for himself is the development of a machine to form the bodies and necks of violins. Much interest has been expressed in this device by experts in that line. Although now 84 years of age, Mr. Ball is still energetic and alert, abreast of the current topics of the day and always ready with some kindly act or word of encouragement, or helpful comment which make his friendship highly valued.

A BOLIVIAN TIN MINE

By E. E. Miller*

Bolivia as a mining country is one of the richest in the world, but the difficulties to be surmounted in securing the mineral are almost inconceivable to American engineers.

Due to a common altitude of 11,500 feet there is practically no vegetation, and little fuel is to be had for power, or to ward off the penetrating cold of the *Alta Planicie*. Fuel for cooking purposes may be had from low brush or *Leña*, and the *Taquia*, or Llama droppings.

Nearly all the mines are found at an altitude of from 13,000 to 17,000 feet, and often the only means of transportation is the Llama, which carries a net load of 100 pounds and eats nothing except the short bunch grass which grows along the trails. Wherever roads exist, carts may be used during half the year, but in summer the heavy rainfall makes the roads impassable.

Power for operating the mines comes from gas producer engines, burning anthracite imported from the States and Europe, and from Diesel engines, burning California and Mexican crude oils. Owing to the fact that Bolivia is really a water shed, forming the rivers farther down on the Atlantic slope, little water power is available, although one company has utilized the ingenious idea of catching the summer's rainfall in a large natural basin, from which they develop some 600 H. P. throughout the year.

Bolivia is one of the largest producers of tungsten, is a large producer of bismuth and antimony, and has been one of the chief sources of tin, which has played such an important part in the making of munitions during the war.

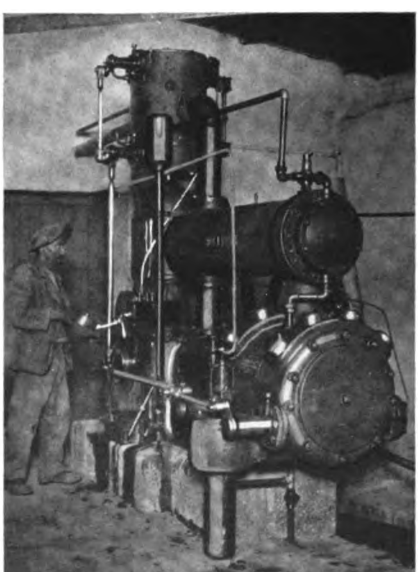
COMPAÑIA MINERA Y AGRICOLA OPLOCA

A company that has been prominent in supplying the allied governments with tin, is La Compañia Minera Y Agricola Oploca de Bolivia, whose mines are near

* Calle de la Coca, Lima, Peru.

Bolivian Women Sorting Ore. Note Llamas and Mine Buildings in the Background

Sullivan Angle Compound Air Compressor at the Oploca Mine



Hoisting Water in a Skin Bailer, Cia. Minera Y Agricola Oploca de Bolivia.

Chocaya, Province of Sud Chichas, Department of Potosi. This station is on the railroad that is soon to give Bolivia an outlet to the Atlantic seaboard at Buenos Aires.

The altitude of the mines, over 13,000 feet, and the natural conditions, typical of the country, have made the operation of the mines most difficult. Despite this handicap, under the able management of Señor Don Augusto Marión, the company produced last year more than 44,000 Spanish quintales (2232 tons), of tin concentrates (*barilla*), carrying 60 per cent of pure metal.

This product was shipped to England, until the past year, when a contract was negotiated with the American Smelting & Refining Company of New York; this being practically the first tin that has been smelted in the States. The highest price received, per ton of pure tin, just before the armistice was signed, was 398£ sterling or about $1870.00 U. S. gold. The present price (April) is around 245£ sterling. From this price are deducted all transportation and smelting charges.

The mine is entered through the *socavon* (cross-cut) "Siete Suyos," which has a length of 250 meters before it reaches the lode. This cross-cut penetrates several veins, the most important being "La Colorada." This vein has a workable length of about 500 meters, and averages about 80 centimeters in width. The milling ore averages about eight per cent tin (cassiterite).

Guia, or ore carrying from fifty to seventy per cent tin, is found in stringers and pockets and does not have to be milled, being shipped direct to the smelter. Stannine, one of the rarest tin ores, is found occasionally.

TIMBERING AND LABOR

Owing to the prohibitive price of timber, which has to be brought from Oregon, the cross-cuts and tunnels are

lined with cut stone, at a cost of 45 Bolivianos ($18.00), per meter. These walls of solid masonry, in addition to being most durable, are a pleasing and imposing sight, and reflect great credit on the mine administration.

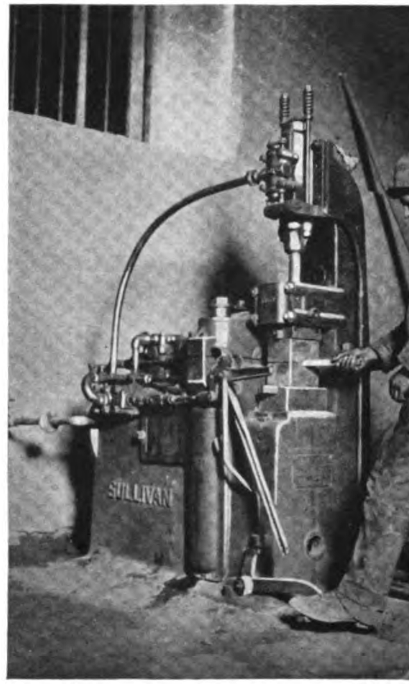
At present, all the mining is done by hand, on contract, the drifts and raises being paid for per meter of advance, and the ore at two Bolivianos per car. As the ore is extracted from the veins, the stopes are filled with waste from the ore and from the vein walls. The ore is dropped to the transportation level through chutes lined with cut stone, and carried up as the ore removal progresses.

The manways afford another interesting feature devised to cut down timber expense. Instead of using ladders, the manways are driven between the levels, on an angle of about forty-five degrees. Steps are then cut, and the men instead of climbing ladders, climb the stairway, which is very much more attractive at this altitude.

The Cholo Indian, the degenerate descendant of the Inca, is the sole source of labor supply, and is possibly the only class of labor that could stand the work in the high altitudes. Stocky, broad of chest and patient, he works without complaint. The Cholo works best on contract, which gives him an opportunity to set his own pace and to take "time out" to chew the inevitable *Coca*.

Like all miners of Latin America, the Cholo establishes at the entrance to the mine a *Capilla* or chapel, at which the ingenuous humbly cross themselves, while the more intrepid and practical make a dinner table of the Altar, from which they consume their delectable *chupe*.

The ore is transported through the Socavon to the "Cancha" by mule haulage, soon to be replaced by electric locomotives. Here it is crushed to about 2½ inch size, the waste and barren pyrite being picked out by Cholo women who receive 1.10 Bolivianos per car of picked



Sullivan Drill Sharpener, Cia. Oploca de Bolivia

Sullivan Pnufeed Rotators in the cross-cut or "Socavon"

ore. The ore is then trammed to the ore bins above the mill.

MILLING THE ORE

All the coarse ore is calcined in self burning kilns, before going to the mill, which has a capacity of about 70 tons per day. This calcining removes part of the sulphur and renders the ore more easily treated. The product of the kilns goes directly to ball mills, is then classified and sent to the jigs and rough concentrating tables.

The first product of the jigs and rough concentrators, with the original fines, goes to automatic calcining furnaces, and hand reverberatories, the calcines of which are reconcentrated on jigs and slime tables and buddles. The first product of these tables and jigs contains the required 60 per cent of *Barilla*.

The seconds and thirds of these tables and jigs go to a Hardinge mill for regrinding. This product is then sent to concentrating tables and slimers for final treatment.

The *Barilla*, secured from these operations, is dried on the top of a wood-fired furnace, after which it is placed in an automatic sampler, which for every ten sacks of *Barilla*, of one quintal each, removes a sample sack of one quintal, or 100 lbs.

This product is transported to the railroad, a distance of six kilometers, in two Jeffrey Quad trucks of two tons capacity each, and is shipped to the seaboard at Antofagasta, Chile, for reshipment to England or America.

The mill is electrically driven throughout, the power being furnished by an Allis Chalmers four cylinder horizontal Diesel engine, driving a 100 KW generator.

About two years ago, a cross-cut 2030 meters long, was started to cut the veins 170 meters below the present workings, or "Siete Suyos." This *Socavon* is 2x2.4 meters in size, and is driven with the triple purpose of exploring the vein at depth, of unwatering the mine and of serving as a transportation tunnel.

For driving this cross-cut, a Sullivan Angle Compound Air Compressor of 628 cubic feet capacity was installed at the mouth of the *Socavon*. Power for this compressor is secured from a Pelton wheel driven by mill water, brought from the mill through a canal one kilometer long.

After the compressor plant was installed, it was discovered that the supply of water had so decreased, that instead of having 75 H. P. available from the Pelton wheel, only 35 H. P. was available. Under most conditions, this would have meant purchasing a smaller compressor with a consequent year's loss in time. To adapt the compressor to the power conditions, it was only necessary to remove the inlet valves from one end each of the high and low pressure cylinders. In this manner the compressor has been running at one half capacity for eighteen months, furnishing ample air for the drills and sharpener.

To date, the *Socavon* has advanced a distance of 1150 meters, or an average of over 200 feet per month. This is an exceptionally good record, considering the class of labor, the increasingly long tram, and the shortage of power.

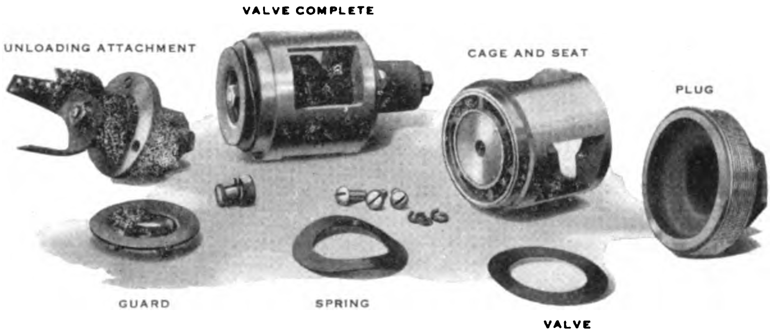
Sullivan "DP-33" Rotators are used in the heading, two machines being used without mountings. These 38 pound drills are held up to their work by the stocky Cholos, and put in six foot holes rapidly. The pneumatic feed mountings, shown in use on page 1167, have also been tried with success; but the native miners are not educated to the use of a bar or column.

A Sullivan "all-hammer" sharpener is installed in the compressor house, furnishing steel with rose bits for the Rotator drills.

As soon as the *Socavon* is completed a new mill for treating 200 tons per day, will be built farther down the cañon. Motor haulage will be installed to bring the ore from the mine to the mill.

The writer is greatly indebted to Mr. A. C. Pollard, General Superintendent, for the information contained in this article.

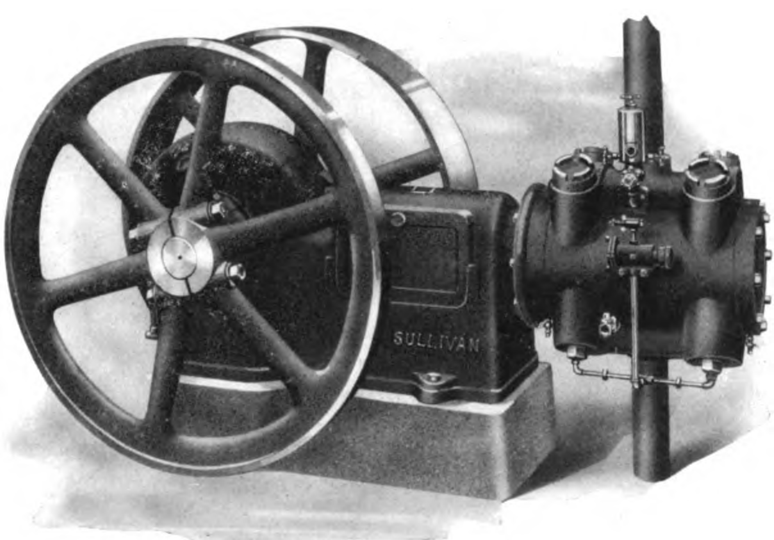
SULLIVAN "WAFER" AIR COMPRESSOR VALVES



Sullivan Wafer Inlet Valve for Air Compressors.

Sullivan Single Stage Belt-Driven Compressors, type WG-6, and the corresponding steam-driven type, "WA-6," are now being supplied with the new improved plate valves, developed by the company's engineers at Claremont, New Hampshire Works. This valve, known as the Sullivan "Wafer" Valve, is shown in the accompanying illustration and on page 1170. The small size, light weight and compactness of the valve and its spring and seat are strikingly illustrated by the other illustration on the same page.

As indicated, the "Wafer" Valves seat in cages arranged radially to the axis of the cylinder and close to the two ends of the cylinder, the inlet valve, being situated at the bottom and the discharge valve at the top. These valves are held to their seats by flat annular springs of



Sullivan "WG-6" Wafer Valve Air Compressor. Capacity, 50-470 Cubic feet

Sullivan "Wafer" Discharge Valve

the same material as the valve itself, which is the finest tempered spring steel obtainable. The valves open against specially designed guard plates, intended to give a wide port opening with a minimum of clearance volume, and without restricting the admission or charge of the air to or from the cylinder. The valve, spring and guard are easily accessible by the removal of a screw plug.

The simple construction and short compression distance of the springs permit the valves to be located much closer to the bore of the cylinder than is generally permissible with valves of this type, with a corresponding reduction in clearance losses. The light weight of the valves and the superior quality of the material result in long life, and when renewals are necessary, the cost of new valves is a trifling matter. The question of repair stock is simplified because the same valves, springs and guards are used for both inlet and discharge.

The valves are employed in multiples of relatively small size, rather than using one or two valves of large diameter, the objection to the large valves being the large clearance pockets required and the likelihood of more noisy action and greater breakage.

Compressors equipped with these valves are unloaded in essentially the same manner as the compressors equipped with automatic poppet valves. There is an airpipe connection from the receiver which is controlled by a pilot valve at the side of the air cylinder. When the receiver pressure rises to the unloading limit, the pilot valve admits air pressure through branch pipes to small plunger pistons located in the valve plugs. The other end of the piston carries a three pronged extension, which raises the inlet valve from its seat until the receiver pressure falls the required amount, upon which the plunger piston falls, the valve seats and the compressor resumes its operation. While the valve is raised and the unloader in action, no air is com›ressed, the piston of the compressor simply carrying the air at atmospheric pressure through the cylinder and open valves.

Sullivan "Wafer" Valves have been in use for several years with great success on high pressure compressors supplied the United States Navy for charging torpedoes at pressures ranging as high as 2500 pounds per square inch. In this service their durability, power economy and ability to maintain a tight seat after long use and the reliability of the special springs which have been developed for this service have all been amply demonstrated.

2d Lt. H. G. Chaffee, U. S. F. A., C. O. T. S., Camp Taylor, Ky.

Dan P. O'Rourke and his Sullivan Drill on the Nevers Railroad cut-off, A. E. F., France

Lt. Robert H. Officer, First Gas and Flame Regiment, A. E. F.

MILITARY SERVICE NOTES

Mr. Walter F. O'Brien was discharged in March as First Lieutenant in the Ordnance Department after his return from France. He is now connected with the Denver Office of the Sullivan Machinery Company.

R. A. Lowry, First Lieutenant, 28th Engineers, has been quarrying rock and building roads in France for more than a year. He was discharged from service this month, and is again a Sullivan sales engineer, now at Denver.

Daniel P. O'Rourke and his FF-12 drill in France are illustrated here. The picture was taken at Camp Sermoise, Nevers, France, and the drill was working at the time on the Great Nevers cut-off, described in Engineering News-Record, April, May and June, 1918. Mr. O'Rourke, following his discharge, has been attached to the Sullivan office at Knoxville.

Word has been received from Montabaur, Germany, of the promotion of Charles H. Tipping to Captain, attached to the Mobile Ordnance Repair Shop of the First Division. Captain Tipping was formerly connected with the Huntington Office.

Lieut. Colonel George W. Blackinton, 353d Infantry, 89th Division, returned from overseas with his unit in May. He was in March promoted to the grade of Lieut. Colonel and returned to his original unit in the Army of Occupation. Col. Blackinton has recently been honored by the French government, by appointment as a Chevalier of the Legion of Honor, for the same action for which he was awarded the Distinguished Service Cross.

H. Glenn Chaffee attended the Officer's Training School at Camp Zachary Taylor, Kentucky, and received the rank of 2nd Lieut. Field Artillery. He has been discharged and has returned to his duties at the Claremont, New Hampshire, Works.

A. G. Collins, formerly of the El Paso Office, was commissioned Ensign U. S. N. R. F. from the Steam Engineering School at Stevens Polytechnic Institute and was discharged in May. He has resumed his position as Sales Engineer for the Company and is at St. Louis.

A MODEL ILLINOIS COAL MINE

By S. Bowles King*

The Nokomis Coal Company at Nokomis, Illinois, 72 miles northeast of St. Louis, in Montgomery County, presents an example of mining practice that is, in many respects, a model for conditions in the central field.

In 1912, The Nokomis Coal Company was organized and acquired mining rights about a mile southwest of the town. The company now owns or controls more than 12,000 acres. The seam worked is known as "No. 6," lies 650 feet below the surface, and ranges from seven and one-half to nine feet in thickness, averaging eight feet four inches.

The Company selected Mr. Joseph P. Hebenstreit, a mining man of many years' experience, as its superintendent, and early in 1913 the main hoisting and air shafts were sunk. These are 17½x11½ feet in size, inside the timbers, and are 500 feet apart, the air shaft being due west of the two-compartment hoisting shaft. The material encountered in sinking varied from very hard limestone to layers of shale and even indurated clay, sand and gravel. Immediately above the coal are six to nine feet of slate and shale, with two five-foot beds of lime rock, permitting the rooms to be opened 28 feet wide.

Shaft Sinking

The shafts were sunk in rapid time, facilitated by a systematic organization and careful planning. Sullivan air-jet sinker hand feed hammer drills were employed, using hollow steel with six-point rose bits. Three eight-hour shifts were worked, each crew consisting of four drillers, four muckers and a shift boss.

The use of hammer drills accomplished a large economy of time and labor cost as compared with hand drilling. A Sullivan straight line steam driven compressor supplied air for the machines.

Holes 4½ feet deep were drilled, and a round of eight to ten holes was frequently drilled in 45 to 75 minutes in the soft shale. In the hard limestone, 28 to 32 holes per round were required. The labor cost per day was $93.00 for both shafts. As the average footage per 24 hours was 4.5 feet advance as compared with 3.5 feet for hand sinking, the saving by using hammer drills amounted to twice $26.50, or $53.00 per day on the two shafts.

Plan of Development

The Nokomis Mine is developed on a modified room and pillar system, which practically amounts to the panel method. Instead of running the main entries north, east, south and west from the bottom, these are driven at an angle of 45 degrees, so that the mine is divided into four main territories, Northwest, Northeast, Southeast and Southwest. This arrangement gives certain advantages in ventilation, which will be spoken of later. The barrier pillars on the main entries are 150 feet thick. All entries are 12 feet wide and air courses are driven 22 feet in width with an entry pillar of thirty feet of coal. The air courses are made permanent by dropping the slate. Cross entries are carried at right angles

Sullivan Air-Jet Drills in the Nokomis Shaft.

* People's Gas Bldg., Chicago

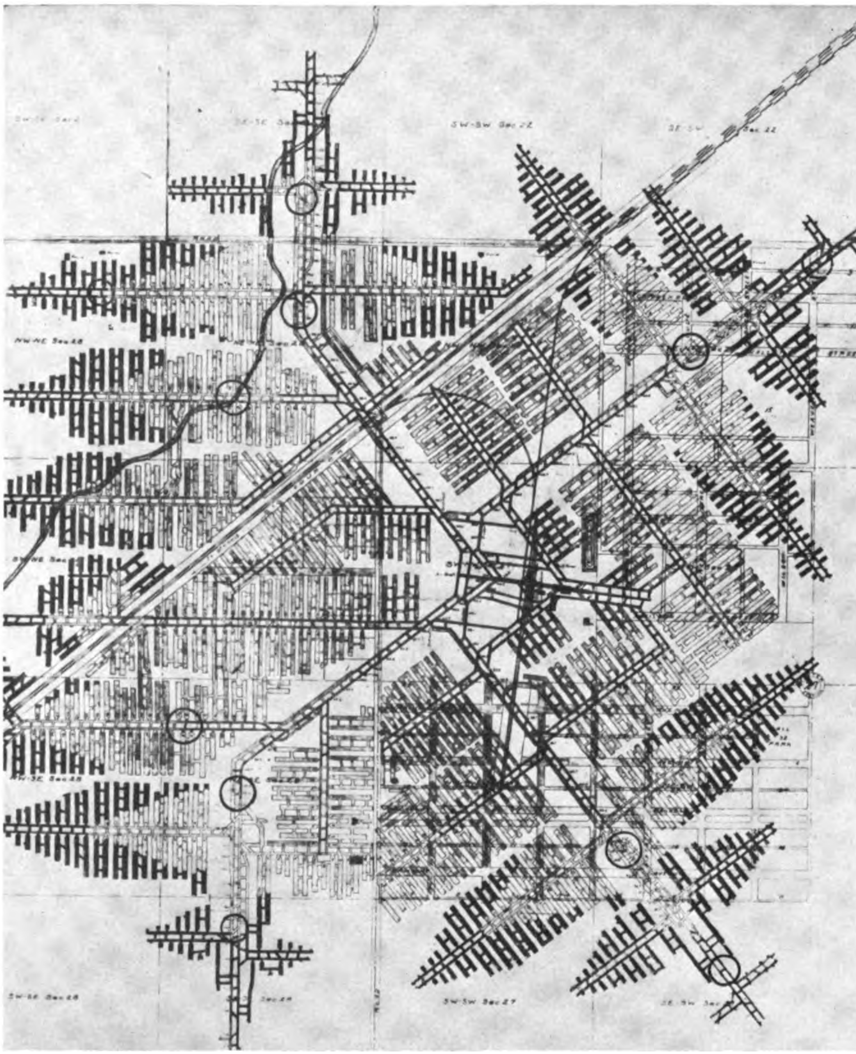


Fig. 12.—Mine Map, Nokomis Coal Company. Workings in full color show operations in 1918-19. Those in lighter tint are areas worked out. The circles indicate transformer substations. The outer circle of two on the same entry shows the site to which the inner substation will be moved, as the mine is developed.

to the main entries, approximately 600 feet from center to center, and on the cross entries, the rooms are opened on 60-foot centers with twelve-foot room necks and 28-foot rooms, leaving a pillar of 32 feet of coal between each two rooms. The rooms are carried 250 to 270 feet in depth with cross-cuts at intervals of 60 feet and twelve feet wide. Cross-cuts on the entries, however, are 10 feet wide.

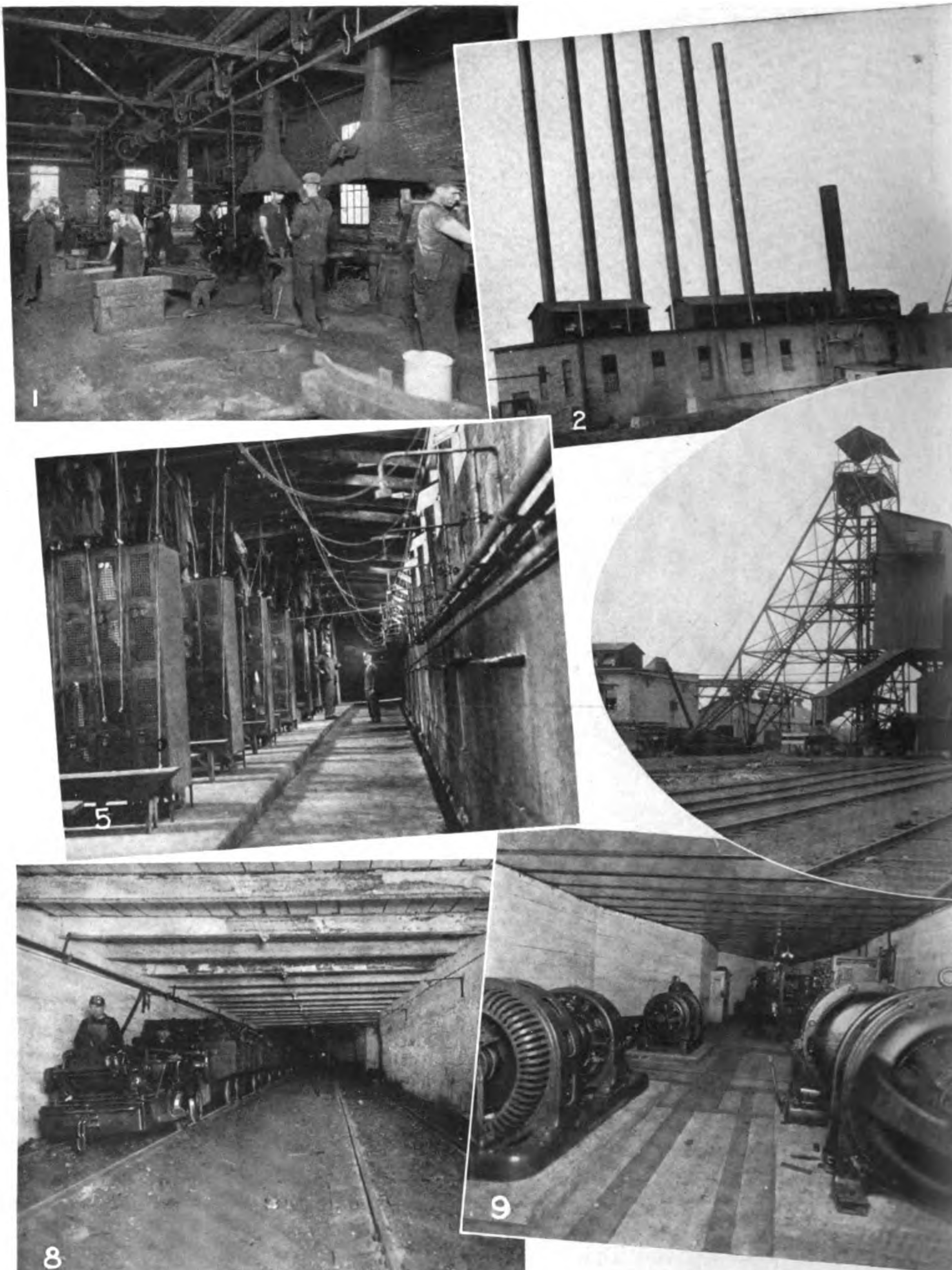
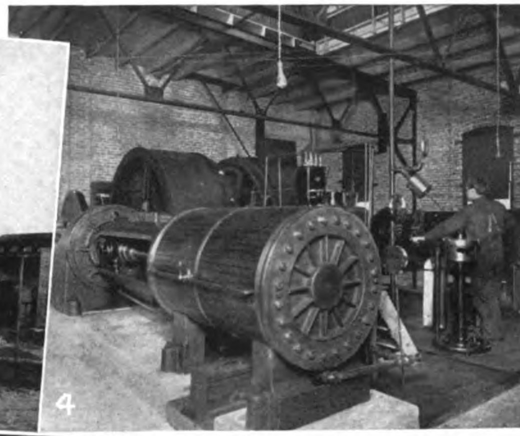


Fig. 1.—Interior of Blacksmith Shop. Fig. 2.—Power House. Fig. 3.—Blacksmith and Carpenter Shop. Fig. 4.– House.—Steel lockers are provided for street clothes and pulleys and slings for drying the miners' pit clothes. F showing 28-foot panel switch board for high tension current. Fig. 8.—Trolley Locomotive and Trip of "Loads" Machine Shop. Fig. 11.—Picking Table, Shaker Screen and Adjustable Loading Booms.



The Hoisting Engine, which handles one thousand five-ton cars in eight hours. Fig. 5.—Miners' Wash and Change g. 6.—Nokomis Coal Company, Nokomis, Illinois, steel tipple and railroad track. Fig. 7.—Underground Power House, n Main Bottom. Fig. 9.—Underground Power House, showing Motor Generators. Fig. 10.—Underground Repair and

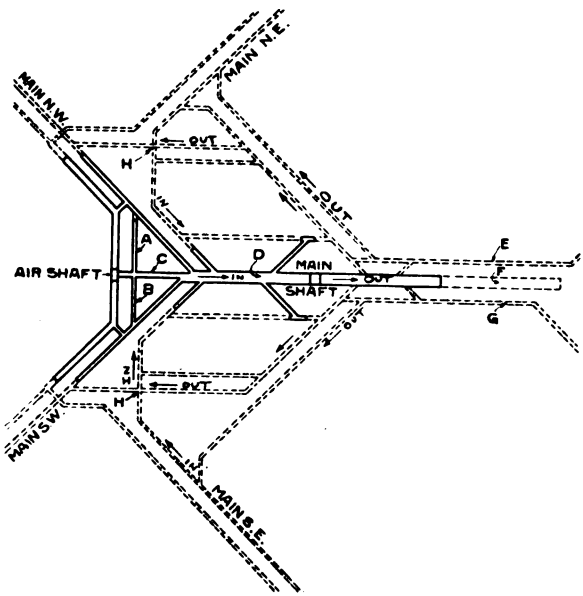


Fig. 13.—Plan of Main Bottom, to show arrangement of entries, run arounds, etc.
(A) Power House
(B) Locomotive Charging Station
(C) Repair Shop
(D) Main Bottom
(E, F and G) Empty Car Storage Tracks
(H) Underpasses for Empty Cars. Arrows indicate direction of cars.

On the accompanying mine map, Fig. 12, the rooms sketched in outline around the main bottom have all been worked out; and as each area is completed, the entries leading to it are walled off by concrete stoppings, so as to close off the inactive portions of the mine altogether.

The mine is at present working the areas indicated by the solid black oblongs, showing the depth to which the different rooms have been carried.

Main Bottom

The main bottom, the heart of the underground workings of the mine, is a most interesting place and naturally the busiest place in the mine at all times. As stated, the hoisting and air shafts are 500 feet apart, the latter due west of the former. This distance is more than abundant for perfect safety. The main bottom itself is 950 feet long with over 450 feet of space west of the hoisting shaft. The bottom is lined with concrete throughout. All coal comes into the bottom from the west and all empties leave the shaft and proceed to the east before being returned to the outer workings. The main bottom is 22 feet wide, giving ample space for handling the cars, locomotives and other equipment. In stations driven from it are found an underground concrete-walled power house where the electric motor generators, motors and switch boards are situated; a concrete repair shop with electrically driven grinders, drill press, a small lathe, etc., where mining machines, tools and locomotives may be completely dismantled if necessary, and major repairs made; a stock room also lined with concrete, systematically arranged with bins and storage trays for practically all repair parts and supplies needed in the operation of the mine; a recharging station with double tracks and pits under each with sufficient accommodation for twenty electric storage battery locomotives to be recharged at the same time: a blacksmith and forge shop and toilet facilities for the men. The entire bottom is fully electric lighted and all work rooms are concreted. The sketch shows the arrangement of run arounds for bringing the loaded trips into the bottom and for returning the empties to the proper quarter of the mine.

Haulage

The track gauge is 42 inches. In the main entry and in the bottom, 40-lb.

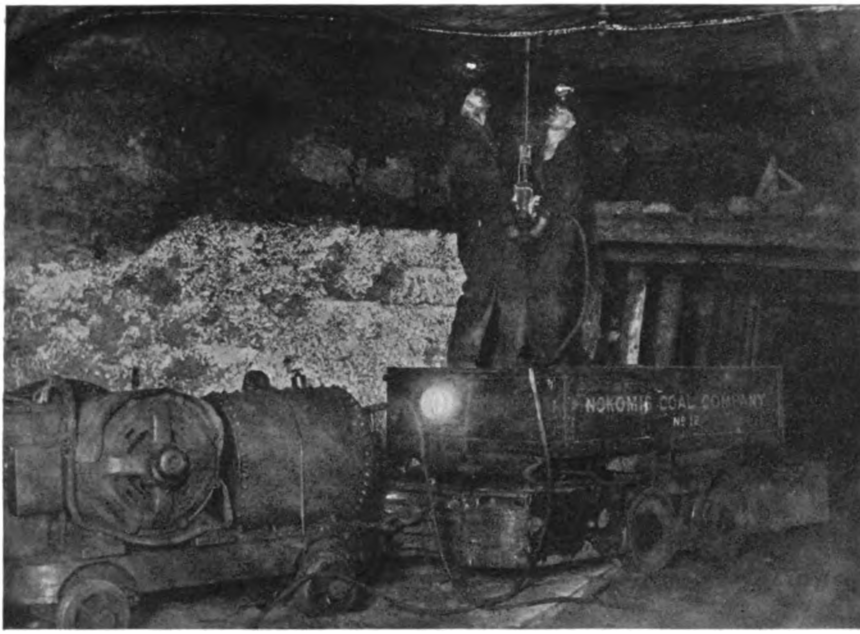


Fig. 15.—Sullivan WK-2 Portable Compressor, Motor-Driven, operating Sullivan Hammer Drill for boring roof holes; operators are standing on one of the company's 17 storage battery locomotives.

Fig. 14.—Ironclad and Runner on Power Truck, ready to move.

Fig. 16.—Underpass for empties coming away from the bottom. The main level, used by inbound trips, is above. (See Fig. 13.)

steel rails are used, while 30-lb. rails are employed on the cross and stub-entries and in the rooms. All curves and turns are laid out at as flat an angle as possible to eliminate the danger of derailing cars.

The track is carried down the center of the room for convenience in handling the mining machines, as well as in loading.

Standard mine cars of 5-ton capacity are employed, built of wood, with roller bearing trucks and draw bar springs.

Animal haulage has been done away with in this mine entirely. The cars are gathered from the rooms and entries and returned to the working places by means of electric "mine mules" or storage battery locomotives, of which 17 are at present employed, seven of these being Mancha and ten Whitcomb locomotives. Six sets of Edison cell batteries have been installed recently. These motors pull the loaded cars out of the rooms, gather them in trips of from six to ten and haul them to the partings, where storage tracks are provided for the loaded cars and for empties. The process is reversed in distributing the empties to the rooms.

At the partings where the inside workings connect with the main entries, the trolley locomotives, of which there are four, two of six, and one each of ten and fifteen tons capacity, haul the trips to the main bottom, and return the empties to the partings.

At the shaft bottom, two tracks are provided, one for each of the two hoisting cages, and there is a slight down grade to the cages, equipped with the usual trips and safety catches for rapid handling of the cars. When it is noted that the full working capacity of this mine is five thousand tons per day, meaning one thousand hoists, it will be seen that rapid and accurate work must be provided for, and the equipment at hand is calculated to do the work safely and continuously. The storage battery locomotives will operate under full load for from eight to ten hours without recharging. Four locomotives are operated at night for distribution of timbers, concrete, powder and other material.

Loaded coal cars enter the bottom over four separate lines from the four quarters of the mine. Large storage space east of the shaft in the main bottom and on adjacent side tracks, permits prompt and ready handling of empties, and enables the trolley locomotives to pick up full trips at all times for distribution to the partings.

"Grade Separation"

The uninterrupted and safe passage of loads and empties is provided for by under-passes at points "H" indicated on the diagram, (Fig. 13). These have been constructed under the main haulage lines, coming from northeast and southeast, so that empties bound to the southwest and northwest pass under at these intersections. This makes all territories independent, and avoids conflicts of locomotives arriving at and leaving the bottom.

All roadways in the entries are maintained in the best condition, the track being laid on substantial oak ties, carefully leveled, making a very smooth-running road bed.

The east side of the shaft is double tracked for 600 feet to handle empty

cars. The slate and shale is shot down and the walls are concreted. This gives over-head room for a second floor for the men as they come out, go up stairs and wait until quitting time. Benches to accommodate 700 to 800 men are provided. This obviates the presence of men on either full or empty tracks, and also prevents them from going across tracks. When ready to go out a man at the foot of the steps limits the number of men allowed on the cage to 20.

Ventilation

As previously stated, the air shaft is 11½x17½ feet in size, and is situated 500 feet from the hoisting shaft, so that in case of accident in the latter, the life of the men underground would not be imperilled by a resulting accident at the same time to the air shaft. The mine is aired by a Sullivan steel plate high speed reversible fan ten feet in diameter by six feet in width, of the double wheel type, with conical steel plate deflectors and multiple vanes or blades. It is operated as a blower, taking air down the air shaft and forcing it through the mine workings and up the hoisting shaft. If desired, the fan may be reversed in less than two minutes, so as to exhaust, without changing any doors. The fan is well housed in a permanent brick building. It is operated by direct connection to a Brownell high speed steam engine, the entire installation being a very substantial one, kept in the best possible condition at all times.

This fan supplies two hundred thousand cubic feet of air per minute against a water gauge of one inch, and has a large reserve capacity hitherto not called upon, although the mine workings have been greatly extended since the fan was installed.

As previously stated, the method of laying out the mine with main entries at 45 degrees from the bottom possesses distinct advantages in securing adequate ventilation. From the mine bottom plan, it will be noted that right angles are avoided wherever possible, so as to decrease the frictional resistance to the course of the air. The current is split into eight separate parts, giving each quarter of the mine two splits of twenty-five thousand cubic feet per minute each. The overcasts are carefully constructed and maintained and are of concrete throughout. All doors in the mine are of the two-leaf center-opening swing type. and are opened by the locomotives without stopping, closing automatically after the locomotive or trip has passed, so that ventilation is interfered with as little as possible in opening and closing the doors. The doors are made very substantially, close so as to make a tight joint and have iron reinforcements to protect them from the shock of the locomotives or cars in opening. It is particularly noticeable in this mine that the air is pure and sweet throughout all of the workings and that there is a good current of air passing at all times. As previously stated, the cross-cuts are carried in the room at intervals of 60 feet, so that the miners at the face are well supplied with air.

Machine Mining

All the coal is undercut before being blasted by means of continuous cutting

Fig. 17.—Loader and car of coal, showing large percentage of lump after machine mining

Fig. 18.— Sullivan A. C. Ironclad at end of Sumping Cut on right rib.

Fig. 19.—Sullivan Ironclad in middle of face cut. H. C. Hebenstreit, Chief Electrician, at right.

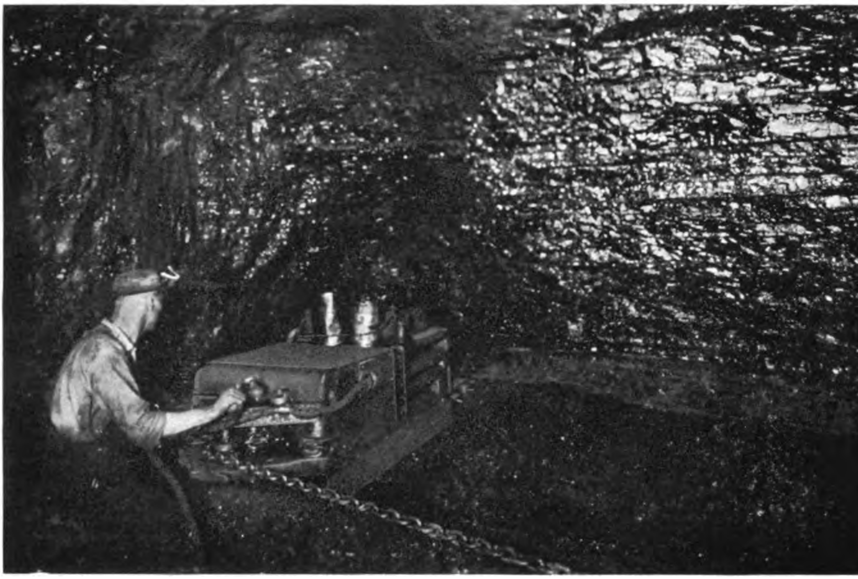


Fig. 20.—Ironclad Machine, squaring corner at left rib, shows undercut at right

Fig. 21.—Ironclad Machine, reloading on Power Truck. Truck is left on track, in center of room, while cutting is being done; also note method of timbering in the room neck.

mining machines of the Sullivan Alternating Current Ironclad pattern. These machines are equipped with 30 H. P. motors and cutter bars 7½ feet in length. Pick point bits are employed entirely, and the bits are set in blocks having a range of nine positions in the cutter chains. This arrangement gives excellent satisfaction in cutting this firm, hard coal.

The kerf or mining made by these machines is 5¾ to six inches high and is made in the coal itself, some three or four inches of bottom being left purposely.

The machine is sumped at the right hand rib, as shown in Fig. 18. The take-up rig or rear jack is then set at the right rib and the front jack or anchor is set at the other side of the room; as the machine cuts the entire face of coal without being withdrawn from under the coal until the left hand rib is reached, see Fig. 20, when it is backed out, remounted on the pan and

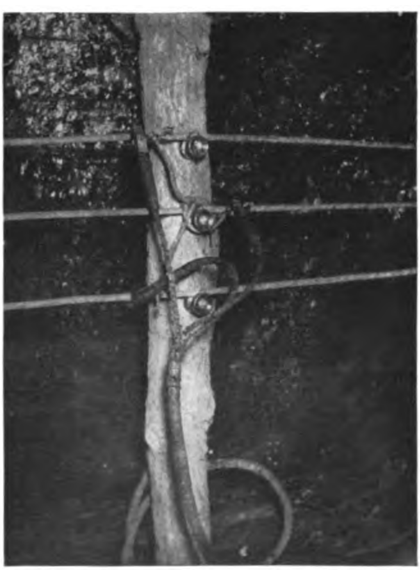


Fig. 22.—Three wire A. C. Feed Lines for Mining machines, and method of connection of trailing machine-cables.

power car and is ready for moving under its own current to the next working place.

Each mining machine has a certain territory assigned to it, consisting of from ten to fifteen rooms, and a certain number of loaders, from fifteen to twenty, assigned to each machine. This arrangement makes it possible to avoid long moves and to have plenty of clean working places ready for the machine to cut, at all times. As high as eight and nine working places have been cut by these machines in a shift's time, under favorable conditions.

An essential feature of these machines is the friction clutch in the driving mechanism, by which the feed gearing is protected against breakage. When an obstruction is encountered, it increases the pull on the friction to the slipping point. These machines develop about 20 H. P. while cutting; and when loading, unloading and moving about the mine four to eight horse power is necessary.

The Sullivan Ironclads take current at around 250 volts, the armatures being wound for 220 A. C. The truck is equipped with a reel on which the trailing cable is paid out or wound up, as the machine advances into the room or is withdrawn from it. The photograph on this page shows the method of attaching the mining machine cable to the feed wires in the entries by means of clips as in the case of the direct current mining machine, except that three wires and three clips are needed.

The particular advantage of alternating current Ironclads lies in (1) The greater convenience and economy of employing alternating current; (2) the ability of the A. C. motors to keep in operation when obstructions are encountered, rather than to stop or stall, as sometimes occurs with direct current machines under difficult cutting conditions. The motors on these machines are of the squirrel cage, induction pattern and are very substantial. No regulating appliances are required on the motor itself and the magnetic leakage

of this type is exceedingly low. A high pulling out torque is secured.

The company has 27 of these Sullivan A. C. Ironclads, and has employed them from the beginning of its operation, not only for work in wide places but also for developing the mine; cutting all entries, cross-cuts and break-throughs with them. An advantage secured by the use of alternating current for the mining machine in this mine is that the voltage is always up to the full tension, securing maximum effectiveness in cutting and handling at all times. The haulage motors are all operated by direct current, so that there is no interference or other demand on the A. C. line to hamper the proper action of the machines.

Power Supply and Distribution

In planning the Nokomis Mine, the company's engineers considered with the greatest care the question of the character of the power supply and the method and cost of distribution. After taking advice from some of the best known commercial electrical engineers in the country, it was decided to use alternating current as the main basis of supply, and as stated above, to cut the coal with alternating current and to haul it with direct current.

Power is carried to the mine from the transmission lines of the Central Illinois Public Service Corporation at Kincaid, 27 miles away, at 33,000 volts. The transformer station, adjacent to the fan house and built substantially of concrete and corrugated iron, contains the high tension transformers which reduce the current for the mine, to 2300 volts, three phase, 60 cycle. At that tension, the current is carried underground, down the air shaft in lead cables. The main supply of current is sent down the air shaft at 2300 volts A. C. to the main panel of the 28 foot switch board. Four oil switches on the board divide the 2300 volt line into four districts. Each district is fed by a No. 1 armored cable to a bank of transformers where the voltage is stepped down to 270 volts A. C. for the mining machines.

At the present time, with the mine developed to a considerable distance from the main bottom, it has become undesirable to carry long lines of low tension A. C. wiring to the outer workings for the machines. The 2300 volt current is therefore carried underground along the sides of the entries to points fairly central with the different working parts of the mine and there stepped down by means of transformers to the 270, volts at which it is lead to the machines.

There are, at the present time, six banks of transformers located in cross-cuts on the inside entries. As the mine advances, it is merely necessary to move the transformers to a new location and continue the armored cables carrying the 2300 volt current up to them. Twenty-four hundred feet is considered the maximum distance for which the secondary current can be economically carried.

The essential safety and economy of this method of distribution is obvious. During the six years of its operation the company has never had a serious accident, due to the use of alternating current, or direct current for that matter. The transformers for supplying the mining machines consist of two banks of three each 25 KVA. and four banks of two each 50 KVA. transformers, each substation

Fig. 23.—Southwest Territory Transformer Station.

being sufficient to handle five to seven machines.

The main feed cables from the outside transformer station to the mine bottom have a capacity of one hundred thousand circular mills on each wire. The low tension, A. C. wiring is 00 and 0000.

Part of the supply is conducted to motor generators, which convert it to direct current at 250 to 275 volts for the operation of the trolley locomotives.

A motor generator set is also provided for converting the A. C. power into direct current at 150 volts, which is the supply for charging the storage battery locomotives.

The switch board, motor generators and transformers are of the latest type and construction, built by the General Electric Company. The switch board is equipped with seven watt hour meters, giving the monthly KW. consumption per ton of coal hauled to the bottom, gathered by the storage battery locomotives and cut by the mining machines.

The 0000 Fig. 8 trolley wires are carried on steel cross bars along the main entries, close to the roof, where there is no danger that men will come in contact with them. The trolley system is divided into five districts, being controlled at the switch board by means of automatic re-closing circuit breakers with a D. C. ammeter in connection with each circuit, thus giving the sub-station attendant control over his road motors.

Rock Removal

All rock removal, such as taking down roof, lifting bottom, trimming side walls, cutting overcasts or break-throughs in rock, drilling bolt holes for hangers, and so forth, is done by means of Sullivan hand-feed hammer drills, operated by compressed air. Air is supplied by a Sullivan Class WK-2 Motor-driven Portable Type Air Compressor mounted on a mine car, complete with receiver, starting panel, etc. This outfit is shown, connected to one of the company's storage battery locomotives, by which it is hauled about the mine, in Fig. 15.

Surface Equipment

As shown by the photographs on pages 1174–5, the surface buildings of the Nokomis Coal Company are modern in type and of first class construction. The tipple is built of steel throughout and loads coal on four railroad tracks. It contains self-dumping cages and shaker screens, also the first pair of raising and lowering booms installed in the State of Illinois for handling coal into cars with the minimum of breakage. These are a valuable aid in picking and sizing the coal. Four scales, 80 feet long and 100 tons in capacity, are installed by means of tipples, enabling the empty cars to be weighed as they come beneath the tipple and the loads to be weighed on the same scales as they pass out. The power and hoisting plant are housed in a single brick building, adjacent to the tipple. Steam for the hoists is provided by six 175 H. P. Brownell self-contained boilers. The tipple is electrically operated from a transformer sub-station on the surface. The hoisting engines are direct connected, having cylinders 28 inches in diameter by 42 inches in stroke and operating two nine-foot steel drums as shown in Fig. 4. The engines were manufactured by the Danville Foundry and Machine Company, and the drums by the Litchfield Foundry Co.

Fig. 31 shows the blacksmith shop, which is one portion of the repair building, which also includes a carpenter and machine shop. There are a separate powder house, oil house and a modern miners' wash and change house, the interior of which is shown in Fig. 5.

A modern and attractive brick office building is a recent addition. The mine is supplied with water from eight deep wells, having a capacity of 140,000 gallons per day, discharging into a surface basin or reservoir near the power house.

Shipping facilities are afforded by side

tracks, connecting with the main line of the C. & E. I. and Big Four Railroads and providing for a storage of 140 empty cars and 140 loaded cars.

At full capacity, the mine employs from 625 to 725 men, and hoists from 4000 to 5000 tons of coal in eight hours.

As has been indicated, the coal is carefully prepared by removing impurities, by picking and by sizing, into the following sizes—6 inch lump, 1½ inch lump, 6x3 inch egg, 6x1½ inch egg, 3x1½ inch nut, 1½ or 2 inch screenings and mine run. Coal from the Nokomis Mine is marketed under the trade mark of Reliance Coal by the Nason Coal Company of Chicago, with offices in the Old Colony Building. Sales agencies are also maintained in Minneapolis and Omaha. Reliance Coal is widely used for both steam and domestic purposes to the extent of 750,000 to one million tons per year.

In securing photographs, and in preparing the above account, the writer acknowledges the assistance of Mr. Albert J. Nason, President; Mr. Joseph P. Hebenstreit, Superintendent at Nokomis; Mr. Edward H. Hebenstreit, Mine Manager; and Mr. Harry C. Hebenstreit, Chief Electrician.

Fig. 24. Train of Lump Coal, leaving the Mine.

THE SEARCHING BUREAU

Co-operating with the Bureau of War Risk Insurance in the work of locating beneficiaries of men who died in service, the American Red Cross, through its Bureau of Allotment Inquiries, has succeeded in tracing 9,700 of its 13,000 cases investigated up to May 1st. The Red Cross bureau is one of the principal agéncies used by the Bureau of War Risk Insurance for this purpose. After every reasonable effort has been made by the Bureau of War Risk Insurance to locate those entitled to the government's checks, the names of the missing beneficiaries are turned over to the Red Cross bureau, and through the Home Service Sections of the organization that exists in the most remote parts of the country, a more exhaustive search is conducted. Red Cross workers canvass the neighborhood where the missing family formerly lived and in most cases manage to trace them.

Mine and Quarry has received an announcement of the establishment of the firm of H. Comstock and H. F. Pigg, Consulting Mining Engineers, with offices at 308 Foster Building, Denver, Colorado. Mr. Comstock and Mr. Pigg have both been with Witherbee-Sherman & Company, Mineville, New York, for many years, the former as general superintendent and the latter as electrical and mechanical engineer.

Sullivan Rotating Water Stoper "DT42," Drilling in a flat stope, 5300-level, North Star Mine, Grass Valley, Calif.

NEW SULLIVAN STOPING DRILLS

Demands of the past few years from the field for a successful stoping drill include the following variety:

(1) Light weight and small size to permit easy handling in high stopes.

(2) Automatic rotation to relieve the drill runner of the incessant labor of turning the drill bit by hand, particularly in hot stopes.

(3) Satisfactory regulation of the strength of the feed.

(4) A water jet for laying the dust when drilling in sulphur bearing ores, or other formations in which dust is injurious to the health of the miner.

(5) Automatic lubrication.

These are general outstanding features, to which must be added in the design of a successful stoper, the usual features of convenience in handling, cutting speed, air power economy, simplicity of construction, accessibility for repairs, stanchness, and ability to resist wear and hard service.

The first four of these elements need not necessarily all be combined in the same machine, but represent varying conditions called for by different fields. The last mentioned features are essential to success in any satisfactory stoping drills.

For the past three or four years, the drill designers of the Sullivan Machinery Company have been studying conditions and developing new features with the object of producing stoping drills to more nearly meet these varying factors of the field. That their efforts have met with success in the types quite recently introduced may be judged from the encouraging reports received as to performance and popularity with operators in many of the leading mining districts of the country.

These new standard Sullivan stopers are shown in the accompanying illustrations. Figure No. 1 illustrates the Sullivan Class DT-44 Light-Weight Hand Rotation machine; Fig. 2, the Light Water Stoper, hand rotated; Fig. 3, the DT-42 Dry Rotating Stoper: and Fig. 4 illustrates the Sullivan Class DT-42 Stoper with Automatic Rotation and Water Attachment.

It will thus be seen that it is possible to furnish a stoper for practically any field conditions, as to character of ground, nature of working or class of labor, which may be encountered.

The Light-Weight Stoper is, as its name implies, a small, short machine, much lighter than any other stoper ever placed on the market. Its net weight is 66 pounds, and with the feed piston

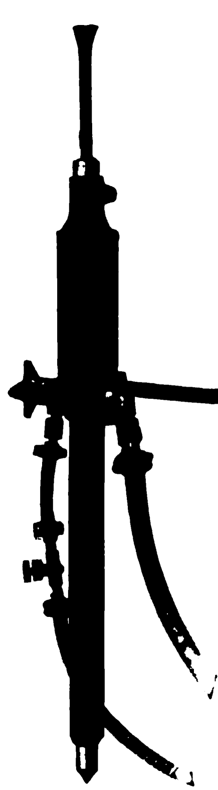


Fig. 1
Sullivan Light Stoper, Hand Rotation "DT44"

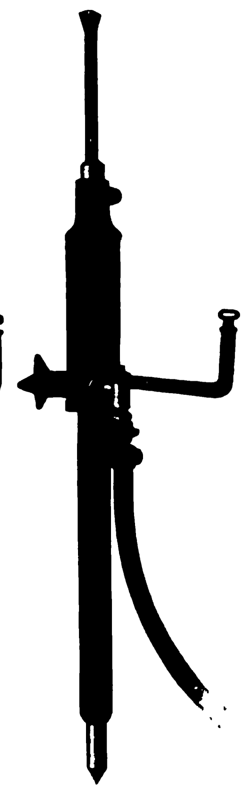


Fig. 2
Sullivan Light Water Stoper, with Hand Rotation, Class "DT44"

drawn in, it is only 48 inches long overall. This shortness permits convenient use in the most confined stopes to direct holes at any desired point, while its low weight enables one man to carry it into narrow working places or up ladders with the least possible difficulty.

ROTATING STOPER

The DT-42 Self-Rotating Stoper is available for hot stopes or other locations in which the demand is for a labor saving machine. This is the first time that a self-rotating stoping drill of satisfactory design has been placed on the market. The difficulty with rotating stopers has been of two kinds: (1) to provide a compact, positive means of rotation and (2) to furnish some practical means of retarding the feed, so that in fitchery ground the feed may be controlled, positively and immediately. With previously designed rotating stopers trouble has been found in these two classes of work, the forward action of the feed, combined with the rotation of the steel, throwing the bit off the inclined surface of the rock, or into the seam or vug, so that a stuck steel or a crooked hole was almost sure to result, with equally sure results in loss of time and labor and frequent damage to the drill itself.

In the Sullivan Rotating Stoper, the rotating mechanism is of the same type that has proved so successful in Sullivan DP-33 Rotator Hammer Drills and in the Sullivan DR-6 mounted water hammer drills. In this design an extension bar, forming an integral part of the piston proper at the front end of the drill, is milled with alternate straight and spiral flutes or grooves, which engage a ratchet collar and a retaining bushing, the latter being screwed into the chuck bushing and transmitting the rotating movement to the drill steel on the return stroke of the piston.

The piston delivers a free blow on the drill shank, the ratchet turning with it. It will be noted that the parts comprising the rotation are all at the front end of the tool. There is no separate rifle bar and the piston is not weakened by a hole bored in the rear end to receive that part, as is necessary with rifle bar rotation. In the experiments of the company's engineers with independent rotating motors mounted at the front end of the machine, it was found that the increased weight at this point caused the machine to be very unwieldy, due to improper balance. The present standard arrangement, while it lengthens the machine, permits a good balance to be maintained, which enables it to be handled a great deal easier than

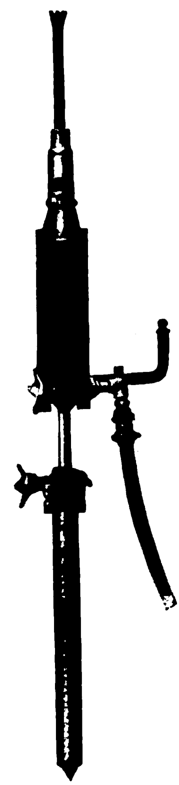


Fig. 3
Sullivan "DT42" Rotating Stoper

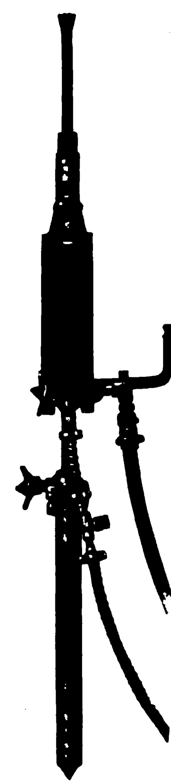


Fig. 5
Sullivan Rotating Water Stoper, "DT42," with Reverse Feed and Brake

would be the case if the extreme front end were over-weighted by a bulky mass of metal. Experience with these new stopers, as well as with the standard hammer drills referred to above, has demonstrated that this form of rotation is substantial, positive and reliable

The second element in the satisfactory rotating stoper, namely, control of the feed, has been the result of much study and experiment.

Feed is provided in the new Sullivan stopers by means of a hand retarder or brake. This is introduced by employing the reverse feed cylinder and piston, which is practically identical with the pneumatic feed mounting of the Sullivan pnufeed rotator. A coil brake band controlled by a handle is located at the front end of the feed cylinder, the band surrounding or gripping the feed piston in such a manner that the air pressure in the cylinder can be counteracted by a turn or two of the hand grip, which is within easy reach of the operator. In spotting a hole with the bit held against the rock by the air pressure, the feed can be braked down to make practically an immovable mounting. When the drill has cut its way ahead to form a satisfactory col'ar for the hole, the brake is released gradually until full feeding strength is secured. The same method is employed for cutting through a seam, loose or broken ground, or a fitcher. By tightening the brake, the rapidity of the feed is immediately reduced to the proper amount, so that the drill does not bury itself in soft ground, or drop out of line in crossing a vug or fitcher. This feature, as demonstrated in actual use in many parts of this country, gives complete adaptability for any ground conditions encountered, from soft broken material to hard, tough, solid rock.

An important element in the success of the Sullivan Rotating Stoper with brake is the method of throttle control. This is the standard Sullivan Stoper Throttle, which is used on all types. With the hose valve turned to its wide open position, the control of the drill and feed cylinder is placed under the one throttle. Turning the throttle first admits air to the air tubes and oil pockets, and in the next position to the feed cylinder, raising the drill to its work. Further turning of the valve causes the hammer to reciprocate slowly and in the final full open position, the machine is operated at full speed and the feed cylinder receives full pressure.

WATER STOPER

The Sullivan Drill designers feel that in the new water feature, which may be incorporated in either the DT-44 Light-Weight or the DT-42 Rotating Stoper, they have at last solved the problem of laying the dust and cuttings in a satisfactory manner. First attempts at this problem consisted of providing an outside water spray by means of which water was drawn from a bucket through a hose on the injection principle and discharged by air pressure alongside the drill steel, against the face of the rock. This method necessitated constant refilling of the bucket and kept the operator in a very wet condition. In addition, it was quite unsatisfactory for drills rotated by hand, and was soon discarded. The next experiment consisted in a water inlet at the front or nose of the drill, taking water from a pressure tank or pipe line. The water was then discharged through the hollow drill steel, being assisted in this discharge by the air pressure, which found its way into the drill steel from the front end of the cylinder.

There was considerable leakage, from the front end of the drill particularly and the miner was apt to be pretty thoroughly wet before the end of the shift. On the other hand, it is customary for runners to operate the Sullivan Water Stoper from one end of the shift to the other, without becoming wet at all, except for an occasional splash from the sludge running from the drill hole. Measurements taken on a

Sullivan Light Weight DT44 Stoper at the North Star Mine, Grass Valley, Calif.

Sullivan Water Stuper boring a vertical hole showed that the area of ground sprinkled by wet sludge from the hole covered a circle having an eight inch radius at the base of the drill.

The form of water jet employed in the DT-42 stoper is that used with such success in the Sullivan DR-6 Mounted Water Hammer Drill and in the water Rotator. It consists of a water inlet to which a hose is attached from a pressure tank or supply pipe. under control of the same throttle which admits air to the drill and feed cylinder. Water is discharged through a central tube running well into the mouth of the drill steel. This water tube is surrounded by a jet of live air, taken from the back of the drill, which forms an effective seal against leakage at the chuck and also provides additional pressure to carry the water through the steel up against the back of the hole, where it is needed. The action of the combined water and air throttle is to admit a small quantity of air to the tube or air jet space first; as the throttle is turned to its next position, the water is introduced and brought to play in the drill hole before the next turn of the throttle starts the piston moving with increasing rapidity. In stopping the machine, the process is reversed, so that the last thing before the air is finally shut off a jet of live air blows through the steel, clearing out any water which may remain in it, and preventing this water from

falling back into the chuck when the air is shut off.

A detail of design which makes for the drill runner's comfort, consists in a deflecting flange or cap, which forms a part of the drill chuck. This contains downward looking ports for the drill exhaust, as in the case in all Sullivan Stopers, so that dust or cuttings falling from the hole are not blown into the operator's face or against the upper part of his body. With the water stoper, these ports act to carry off without inconvenience to the runner, any sludge or water, which may run down the steel from the hole and find its way into the front end of the machine.

The great satisfaction reported by runners and mine superintendents alike, from many parts of the country, indicate that in this new machine, a satisfactory self-rotating water stoper has at last been developed.

AUTOMATIC LUBRICATION

With each stroke of the piston, a measured quantity of oil is drawn from a reservoir in the handle into the working parts of the drill. A supplementary oil pocket in the throttle valve casing is provided, which fills automatically with oil, when the machine is not in operation. On the opening of the throttle, the entrapped oil is blown into the air inlet passages of the cylinder, after which the automatic lubrication goes into effect. In the automatic rotation type, the rotating mechanism is lubricated by an independent oiler in the throttle valve, which blows oil into the ratchet chamber each time the drill starts working. In add tion the chuck housing is furnished with a grease chamber, from which the rotation parts are lubricated.

These new Sullivan Stopers are both of the valveless pattern. The air thrown piston is of the simplest possible design and the cylinder is of one diameter throughout. In this design, the effort has been made to overcome previous detriments to valveless drills, consisting of high air consumption per unit of work done, and a rapid diminution of efficiency with increased wear. The Sullivan design embodies unusual simplicity in the number and shape of the working parts. The piston is equipped with ample bearing surface to insure it against wear and the design is such that when wear does occur, with inevitable increase in air consumption, the drilling speed will not be materially reduced, and the cushion which is provided at both ends of the piston travel is still retained in full effectiveness to protect the machine against undue jar and breakage.

GENERAL FEATURES

As to drilling speed, results speak for themselves. Reports from different sections of the field indicate that the machine measures fully up to the builder's expectations in this important particular. The principal factors which determine drilling speed are force and frequency of blow. The relation of these two elements has been so balanced in this design that average ground and air pressure conditions are met to the best advantage with regard to the shock to which the drill steel is subjected and the wear of the gauge of the drill bit. As these two factors also affect the ease with which the drill is rotated and the operating balance of the machine, it is interesting to note that drill runners, everywhere, are enthusiastic about the new Sullivan Stoper.

IS YOUR STEEL TOO LONG?

By F. M. Lee* and J. A. Noyes†

The proper length of drill steel and the number of pieces of steel in a set to drill to a given depth form a question which should be given more serious consideration than appears to be the case in some mining districts. Too often the governing feature seems to be the length of the feed screw of the rock drill or hammer drill in use. A customary feeding length or run is two feet. Consequently the inference seems to be that 24 inches is automatically determined as the proper length of steel changes, and for drilling, say, a ten-foot hole, five steels will be used, two, four, six, eight and ten feet in length respectively.

This practice is justified, provided the rock in which the drilling is being done is not so hard, or so abrasive as to wear the gauge or dull the bit unduly. In many mining districts, where the question of drilling efficiency has been carefully studied, the character of the ground is considered the determining factor, and steel is furnished to the drill runners in 12-inch lengths or even in nine-inch lengths in extreme cases, even though the drilling machine is equipped to handle a twenty-four-inch or longer run.

A bit whose cutting edge is dulled in the first 12 inches of the run or whose gauge loses one-eighth of an inch or more in the same distance, certainly cannot drill efficiently for the second twelve inches of a 24-inch run. If a new steel of the same length is inserted to finish the run, it naturally has the same starting gauge as the worn bit, and the result is that if the hole is bottomed at all, it is only by throwing an undue strain on the cylinder and rotating mechanism of the drilling machine, by excessive sledging of the steel or by squibbing, which takes considerable time and wastes powder and fuse. The chances are about even that the bit will be broken or stuck in the hole in the operation.

It should be pointed out that if steel is made up in 12-inch lengths, there is nothing to prevent skipping a length and drilling 24 inches with the next longer steel, where conditions are favorable.

DOUBLE TAPER BIT ECONOMICAL

Another important factor is the change in gauge with each successive length of steel, and the shape of the bit itself. Many mines are still using a change of gauge as large as one quarter of an inch for each run of 24 inches. The bits used in such cases have the ordinary straight taper, which usually is 14 degrees or thereabout. Experiments which have been detailed in previous issues of Mine and Quarry have indicated that the Sullivan Double Arc bits with a five-degree taper, running about one inch back from the cutting face, and carrying a 14-degree taper from that point to the rear end of the wing, provide very much greater cutting efficiency. This is indicated by the fact that the gauge changes may be cut down fifty per cent, thus decreasing the size of the starter or first run of steel materially, and at the same time, permitting a hole of the same diameter to be bottomed as was secured with the old style bits. At a mine in the Joplin district, using double arc bits of one-eighth-inch variation in gauge, the tonnage per drill shift has increased twenty per cent since these bits were substituted for crossbits with one quarter-inch drop in gauge. This drilling was done in "stope" (flat) holes ten to fourteen feet in depth for one and one-quarter-inch powder. The starters formerly used with single taper and cross bits were three inches in gauge. The starters at present used with the Double Arc, double taper bits are two and three-eighths inches in gauge.

At another mine in the same district, a

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saving of twenty per cent in cost per ton per drill shift is being made by this means as compared with the cross bits, having single taper.

TONNAGE PER STEEL SHARPENED

At a mine in the Republic District of Northern Michigan, which formerly used 14-degree single taper bits, double taper bits were substituted with the following results:

The gauge of the starting steel was decreased from 2½ inches to 2¼ inches. It was possible to secure a ten-inch run from each steel instead of an eight-inch run as was the previous case. The drop in gauge is one-eighth inch. During January and February, 1918, 18,096 tons of ore were mined and 17,581 steels were sharpened. During November and December, 1918, 24,940 tons of ore were mined and only 10,991 steels had to be sharpened to produce this tonnage. During the first two months of the year, the old type of bit was in use. During the last two months, the new type of bit was used exclusively. With the old bit, 1.05 tons of ore were broken per steel sharpened, while with the double taper bit 2.25 tons of ore were broken for each steel that went to the blacksmith shop for re-sharpening.

The double taper, double arc bit to which reference is made above can be sharpened by hand with suitable dies and dollies, but can be made up much more accurately and, of course, very much more rapidly in Sullivan Drill Sharpening Machines, which can be equipped for this purpose with special adjustable gauging dies on the vertical hammer, providing for sixteen changes in gauge on the same set of dies by merely adjusting a thumb screw and key.


Sullivan Double Arc Double Taper Bit

SULLIVAN OFFICE CHANGES

Phillip F. Jarvis has resigned his position as sales manager for the territory controlled from the St. Louis Office of the Sullivan Machinery Company. The following changes have been announced:

Marion C. Mitchell has been appointed sales manager for the territory in Indiana and Illinois previously controlled from the St. Louis Office, with temporary headquarters at 2006 Railway Exchange, St. Louis.

Don M. Sutor, formerly manager of the El Paso Office, has been appointed sales manager for the territory of western Kentucky, western Tennessee, Missouri, Arkansas, Oklahoma and Kansas (except the oil territory), with headquarters at 2006 Railway Exchange, St. Louis.

Daniel H. Hunter has been appointed sales manager for Louisiana, Texas (except the southwestern section) and the oil fields of Oklahoma and Kansas, with headquarters in Dallas, Texas.

Corporal Charles H. Coffin, Quartermaster Corps, A. E. F., was married in June to Mlle. Marie Ferandy, at Paris. Corp. Coffin, formerly attached to the Huntington Office of this company, was in the quartermaster's department at St. Nazaire until the first of the year, and has since completed a course of study at the Sorbonne, Paris. He is expected home this month.

The Sullivan Machinery Company announces the establishment of a new branch office at 810 Park Building, Cleveland, Ohio, under the management of Mr. Ralph T. Stone, for several years past Sales Engineer associated with the New York Office of this company.